P.O.L.

# CLASS A NETWORK DATARING GAUGES
# 1988 DATA PROCESSING AND ANALYSIS

BY
S.M. SHAW

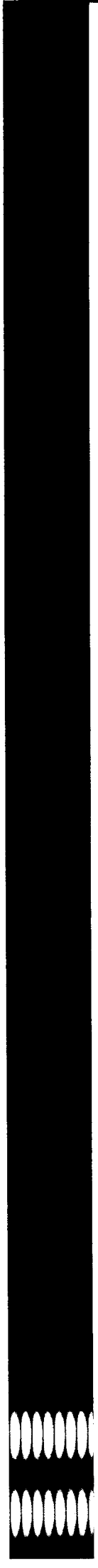
REPORT NO. 9
1989

NATURAL ENVIRONMENT RESEARCH COUNCIL
PROUDMAN OCEANOGRAPHIC LABORATORY

**PROUDMAN OCEANOGRAPHIC LABORATORY**

**Bidston Observatory**
**Birkenhead, Merseyside, L43 7RA, UK**
**Tel: 051 653 8633**
**Telex: 628591 Ocean B**
**Fax: 051 653 6269**

Director: Dr. B.S. McCartney



*Natural Environment Research Council*

PROUDMAN OCEANOGRAPHIC LABORATORY

REPORT No.9

# Class A Network Dataring gauges
# 1988 data processing and analysis

S.M.Shaw

1989

# DOCUMENT DATA SHEET

*AUTHOR*
S. M. SHAW

*PUBLICATION DATE* 1989

*TITLE*
Class A Network Dataring gauges - 1988 data processing and analysis

*REFERENCE*
Proudman Oceanographic Laboratory Report, No.9, 124pp.

*ABSTRACT*

This report presents a summary of sea level data processing for 1988 from 15 Dataring sites around the UK coast.

Details of processing, reference levels, statistics and analyses are included.

This work is funded by MAFF.

*ISSUING ORGANISATION*
Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside L43 7RA
UK

Director: Dr B S McCartney

*TELEPHONE* 051 653 8633

*TELEX* 628591 OCEAN B

*TELEFAX* 051 653 6269

*KEYWORDS*
SEA LEVEL MEASUREMENT
SHORE BASED TIDE GAUGES
TIDAL RECORDS
SEA LEVEL MEASUREMENTS
DATA PROCESSING
NORTHWEST EUROPEAN WATERS
BRITISH WATERS

*CONTRACT*

*PROJECT* MLS-61-1

*PRICE* £29

CONTENTS

## 1.INTRODUCTION

The 'Class-A network' of some 35 tide gauge coastal sites around the British Isles was instigated after the 1953 severe flooding event to facilitate storm and mean sea level studies (HOME OFFICE 1954).

Originally the recordings were by a chart/pen/float system producing graphical records where the analytical procedures were very labour intensive, time consuming and reliant on the attentions of a local operator.

In recent years the network is being subjected to a major modernisation program.The sites are gradually being furnished with sensors and micro-processors whereby sea levels may be accessible in close to real time from a central site.This system is known as the Data Acquisition for Tidal Applications for the Remote Interrogation of Network Gauges,or Dataring.

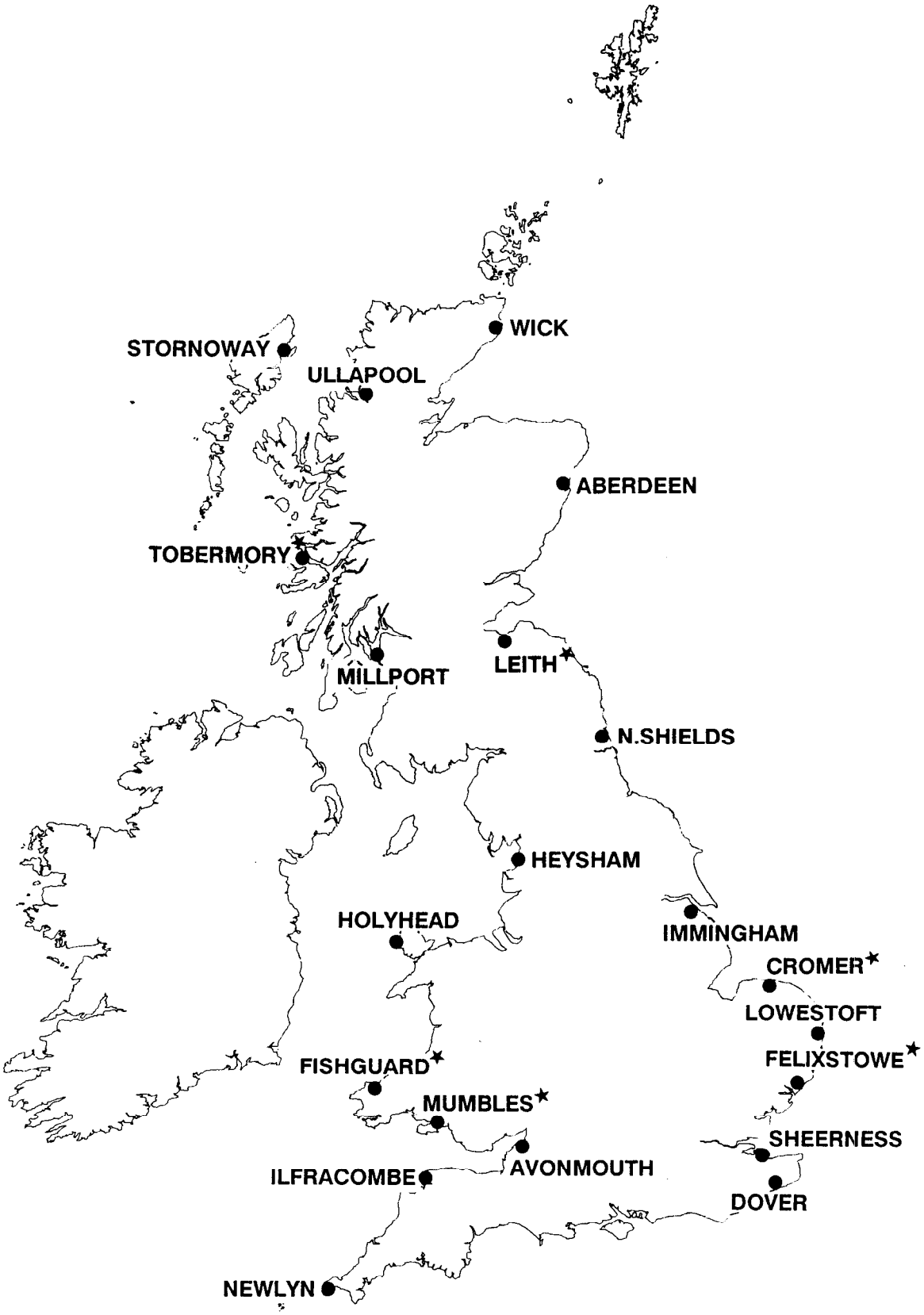
Twenty-one sites are currently interrogated via the Dataring system and of these, all but five have been accessible in excess of a year.(Figure 1) However,system and communication problems have reduced the data series for 1988 to 15 worthy of detailed study,the results of which are presented in this report .

Section 2 contains a general description of the system configuration and methods of recording elevations on site,with descriptions in geographical order,clockwise from Newlyn of each site's instrumentation, reference levels and details of processing.

It includes harmonic constants from an independant analysis of the 1988 data and presentation of the hourly observations in the form of frequency distribution and cumulative frequency curves.

Section 3 contains the 1988 statistics for extreme and mean sea levels and surge residuals,the differences between the observed and predicted levels, for all 15 gauge sites.It also includes a brief outline of the meteorological situation for some of the larger storm events during the year.

Section 4 contains introductory material to gauges operational in 1988 but not included in the main text.




★ Recent installations

Figure 1

## 2. GENERAL DESCRIPTION OF SITES AND PROCESSING

All sites which are modernised to facilate the Dataring form of interrogation are furnished with a minimum of two sensoring systems as an insurance against excessive data loss.

These sites are frequently also furnished with chart recorders or tape facilities for Harbour Master's convenience and back-up in case of total Dataring interrogation failure.

The sensors on Dataring are either quartz crystal (digiquartz) linked to pressure point gauges or potentiometers linked to either a well-head unit or the float of a stilling well gauge where these already exist on site. Each site therefore has two channels of recording with a combination of these ie. 2 digiquartz sensors,or a digiquartz sensor and potentiometer on a well-head unit,or two potentiometers, one linked to a well-head unit and the other to a float gauge operating in an adjacent stilling well.Figure 2 shows a typical well-head unit with potentiometer attached.

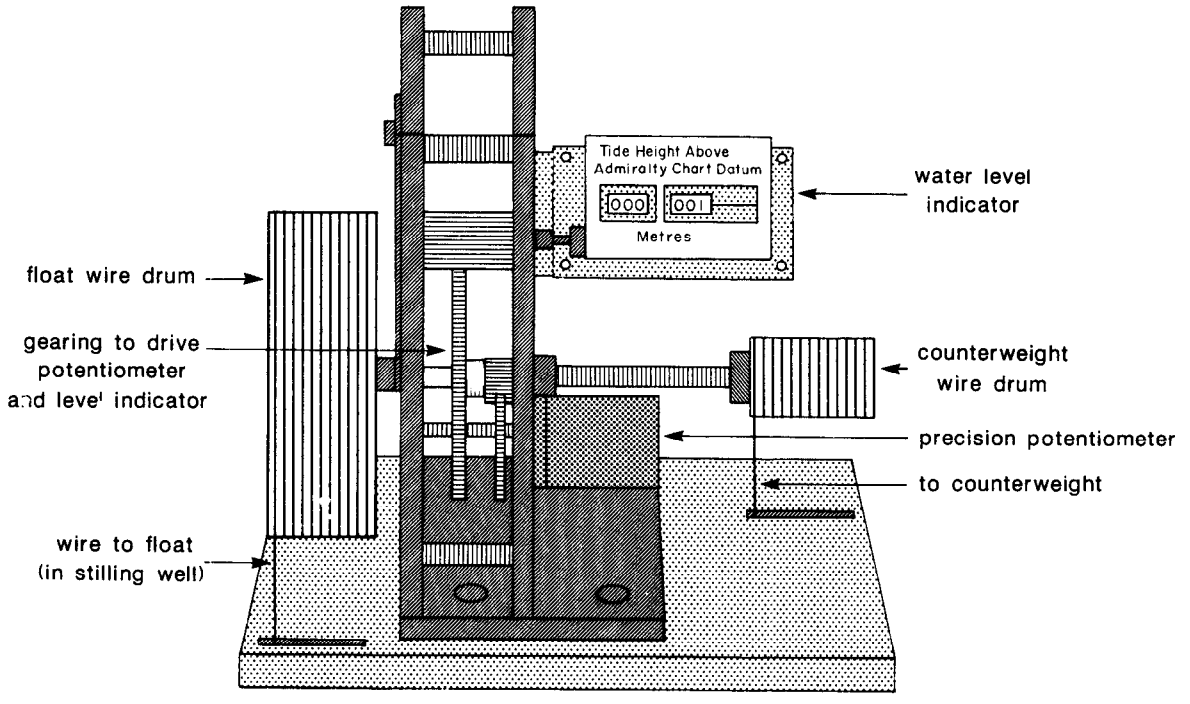



Figure 2

For data reduction and statistical purposes, each site is treated as having a primary (Class-A) data channel and a back-up channel of recorded data. Elevations,corrected to local Chart Datum within the on-site microprocessor and integrated at 15-minute period are collected regularly at the Central processing centre located at the Proudman Oceanographic Laboratory.

Data from the two channels are checked and compared for spurious values or instrument errors.

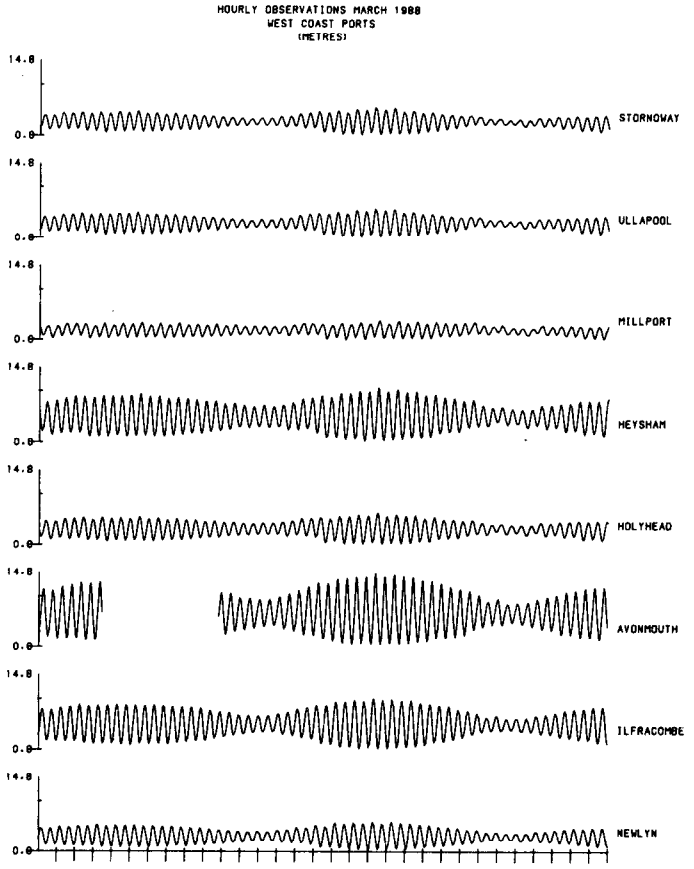
In the case of the Class-A channel, after initial editing and checking procedures, the elevations are filtered to hourly levels using a low-pass filter.

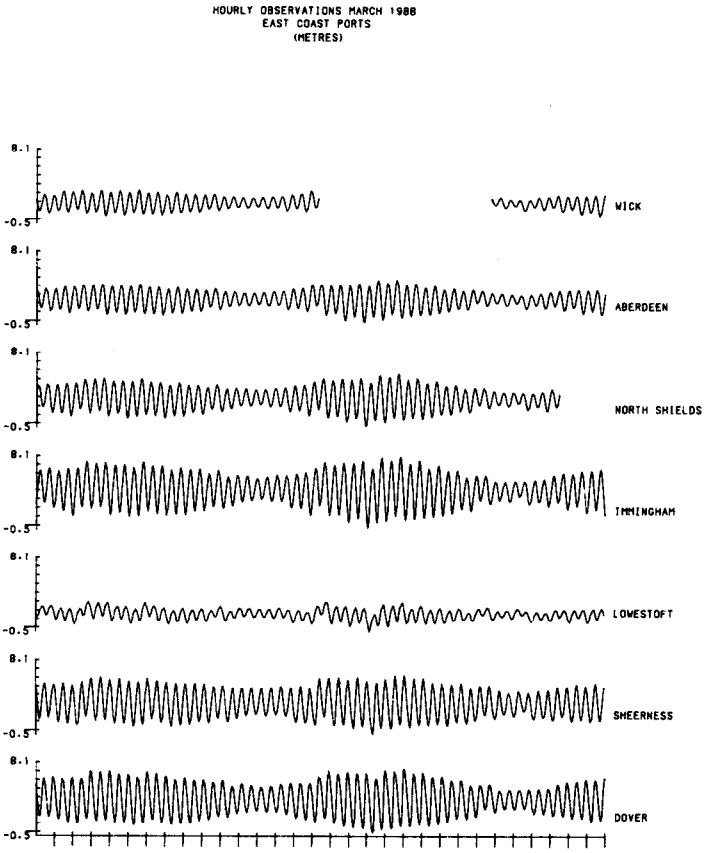
Figure 3 shows hourly levels for all ports to illustrate the different tidal ranges at the Spring Equinox (March) and the Summer Solstice (June).

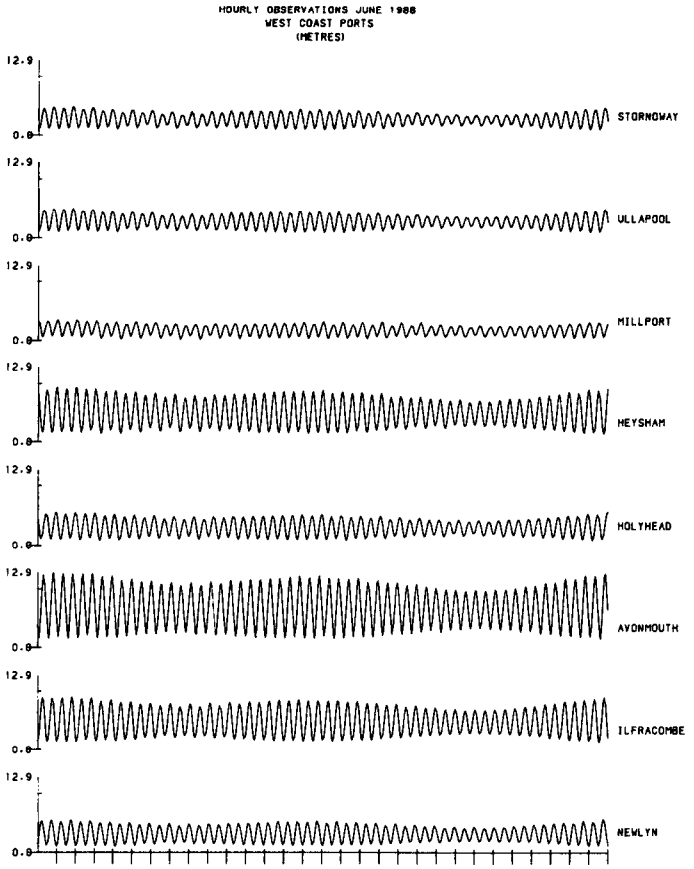
The values are then compared with hourly predicted levels from the best analysis available,usually based on long period data sets,to ascertain initial presumptions of datum stability and correct timing.

Any errors found may be flagged and corrected by use of the Tidal Elevation and Reduction Package (GRAFF & KARUNARATNE 1980), a suite of computer programs designed to simplify data processing.

Results are then available for further analytical study and statistical procedures such as the extraction of extreme levels and mean sea level values as presented in Section 3 of this report.


HOURLY OBSERVATIONS MARCH 1988
WEST COAST PORTS
(METRES)
14.8
0.0
STORNOWAY
ULLAPOOL
MILLPORT
HEYSHAM
HOLYHEAD
AVONMOUTH
ILFRACOMBE
NEWLYN


HOURLY OBSERVATIONS MARCH 1988
EAST COAST PORTS
(METRES)
8.1
-0.5
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER


HOURLY OBSERVATIONS JUNE 1988
WEST COAST PORTS
(METRES)
12.9
0.0
STORNOWAY
ULLAPOOL
MILLPORT
HEYSHAM
HOLYHEAD
AVONMOUTH
ILFRACOMBE
NEWLYN

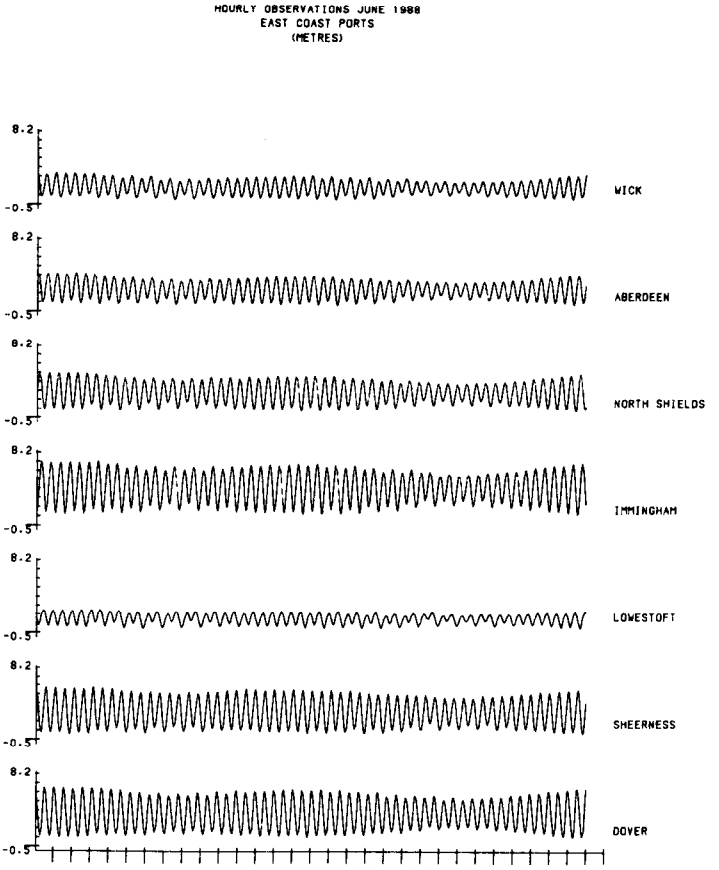

HOURLY OBSERVATIONS JUNE 1988
EAST COAST PORTS
(METRES)
8.2
-0.5
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER

Figure 3

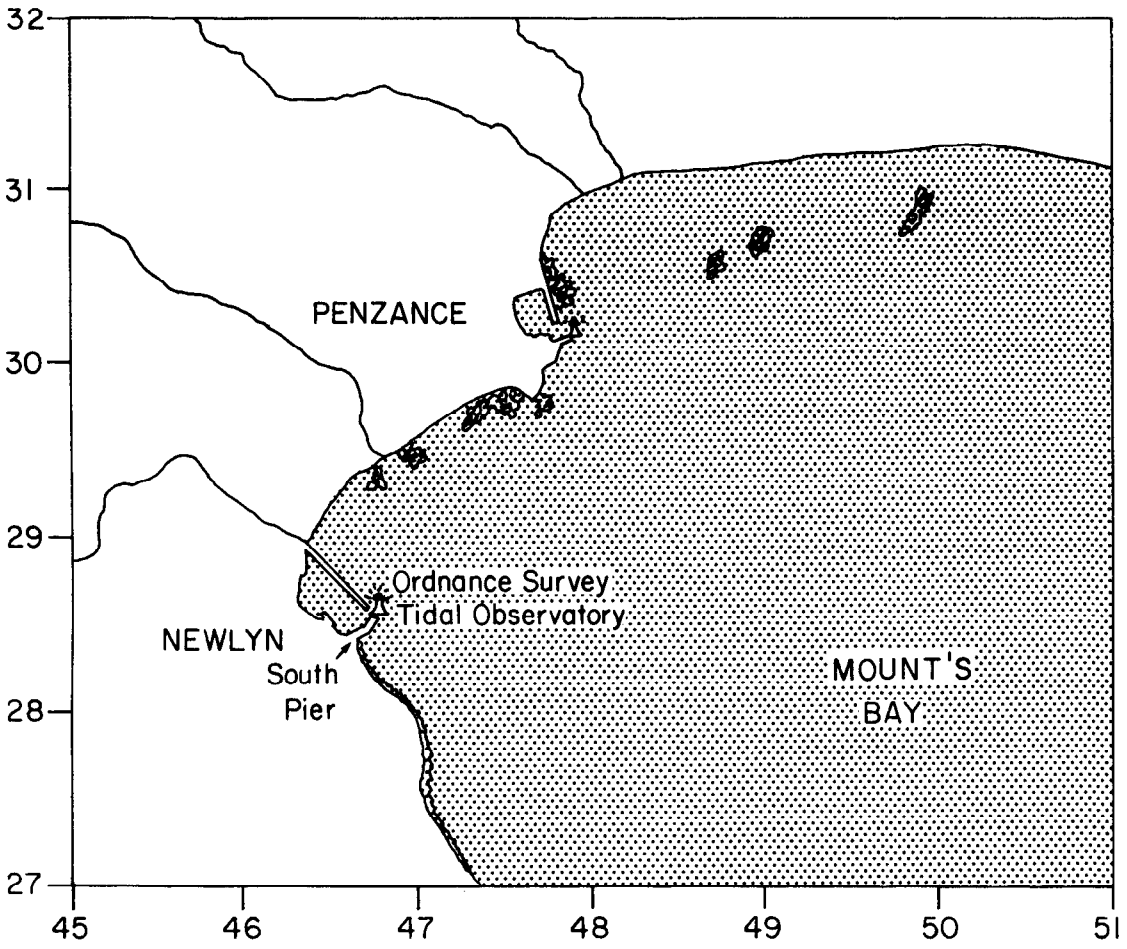
## 2.1 NEWLYN

Latitude 50 deg 6' 8.7"N Longitude 05 deg 32' 30.0"W

National Grid reference SW 4676 2855

Recording zero = Chart Datum = 3.05m below Ordnance Datum Newlyn

Recording zero = 7.8012m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | SW46762855 | OSBM Bolt inside hut adjacent to well |
| Aux1 | SW46732851 | Fl Br 1565 wall South Pier NW face 17·8m SW |
| Aux2 | SW46592841 | Fl Br 1520 wall SE side S Pier Rd NW face |

## Data processing

The tide gauge installation is sited within the Observatory Building on the South Pier.Since the site was modernised in 1983,raw sea level data have been regularly collected from two sensors on the Dataring system:

Potentiometer attached to Munro gauge (Channel 1 back-up)

Digiquartz on pressure gauge system (Channel 2 Class-A)

Both channels have been operating since September 1983, but with many gaps in the data until 1987.

In addition there is a sea-water temperature sensor operating on the same system.

After initial editing of spurious values in the raw sea levels, hourly heights have been filtered from the Channel 2 readings, whilst Channel 1 output is kept for comparison purposes only.

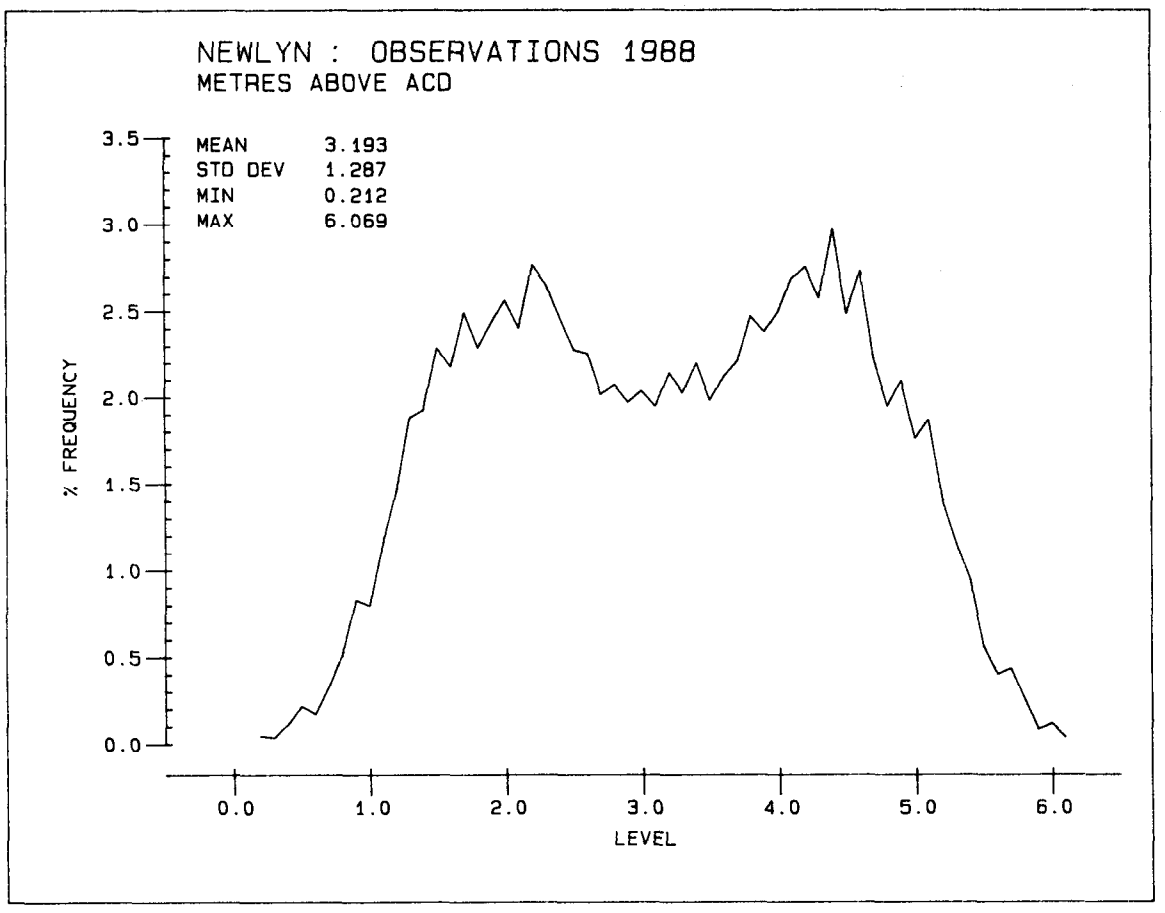
Missing values in the raw data in 1988 were interpolated for the following dates : Jan 5,20, Feb 23, Mar 10,Apr 6,14,29,May 5,Jun 7,11, Sep 21,Oct 13, Nov 5,9,28, Dec 8,10,20,21.

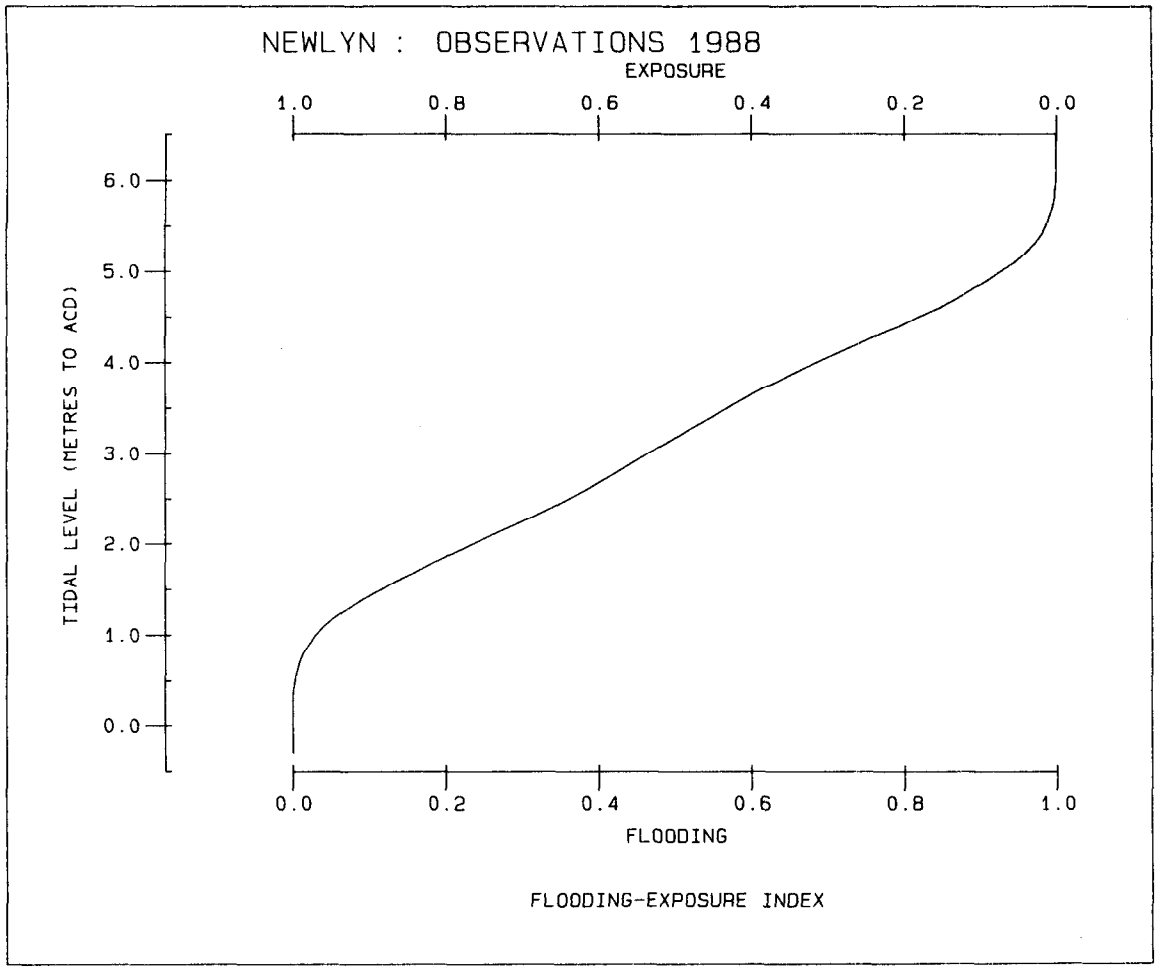
## Gaps in Channel 2 processed data for 1988

Nil gaps.

## Site Diary

26 July Break-in to tide gauge hut reported. No apparent damage.


NEWLYN : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 3.193
STD DEV 1.287
MIN 0.212
MAX 6.069
% FREQUENCY
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
LEVEL


NEWLYN : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, SOUTH COAST - NEWLYN

LATITUDE: 50 06' 08.7" N

LONGITUDE: 5 32' 30.0" W

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 3.194

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 3.05 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.3195D+01 RESIDUAL MEAN = 0.2232D-06
STD DEV = 0.1288D+01 STD DEV = 0.1238D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.019 | 292.60 |
| O1 | 0.054 | 340.90 |
| P1 | 0.020 | 97.78 |
| K1 | 0.062 | 108.66 |
| J1 | 0.003 | 215.49 |
| 2N2 | 0.049 | 118.48 |
| N2 | 0.331 | 112.99 |
| M2 | 1.718 | 133.17 |
| S2 | 0.581 | 177.13 |
| K2 | 0.166 | 174.90 |
| M3 | 0.011 | 24.83 |
| M4 | 0.115 | 165.45 |
| MS4 | 0.077 | 216.89 |
| M6 | 0.009 | 326.48 |

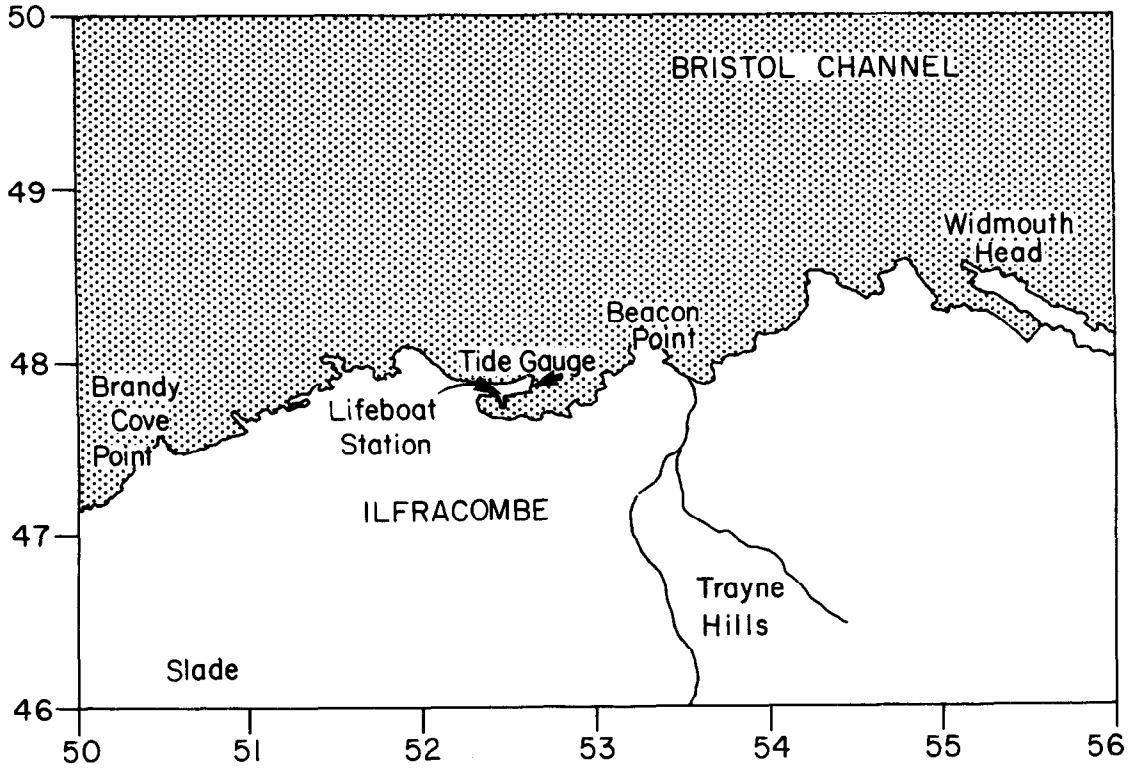
## 2.2 ILFRACOMBE

Latitude 51 deg 13' 0.0"N Longitude 04 deg 07' 0.0"W

National Grid reference SS 5263 4791

Recording zero = Chart Datum = 4.8m below Ordnance Datum Newlyn

Recording zero = 12.379m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | SS52634791 | OSBM Bolt conc. pier S angle TG hut |
| Aux 1 | SS52454782 | Pier Hotel, The Quay |
| Aux2 | SS52514789 | St.Nicholas Chapel, Lantern Hill |
| Aux3 | SS52494786 | Fl Br G4851 Lifeboat Stn. E face NE angle |

Data processing
.....

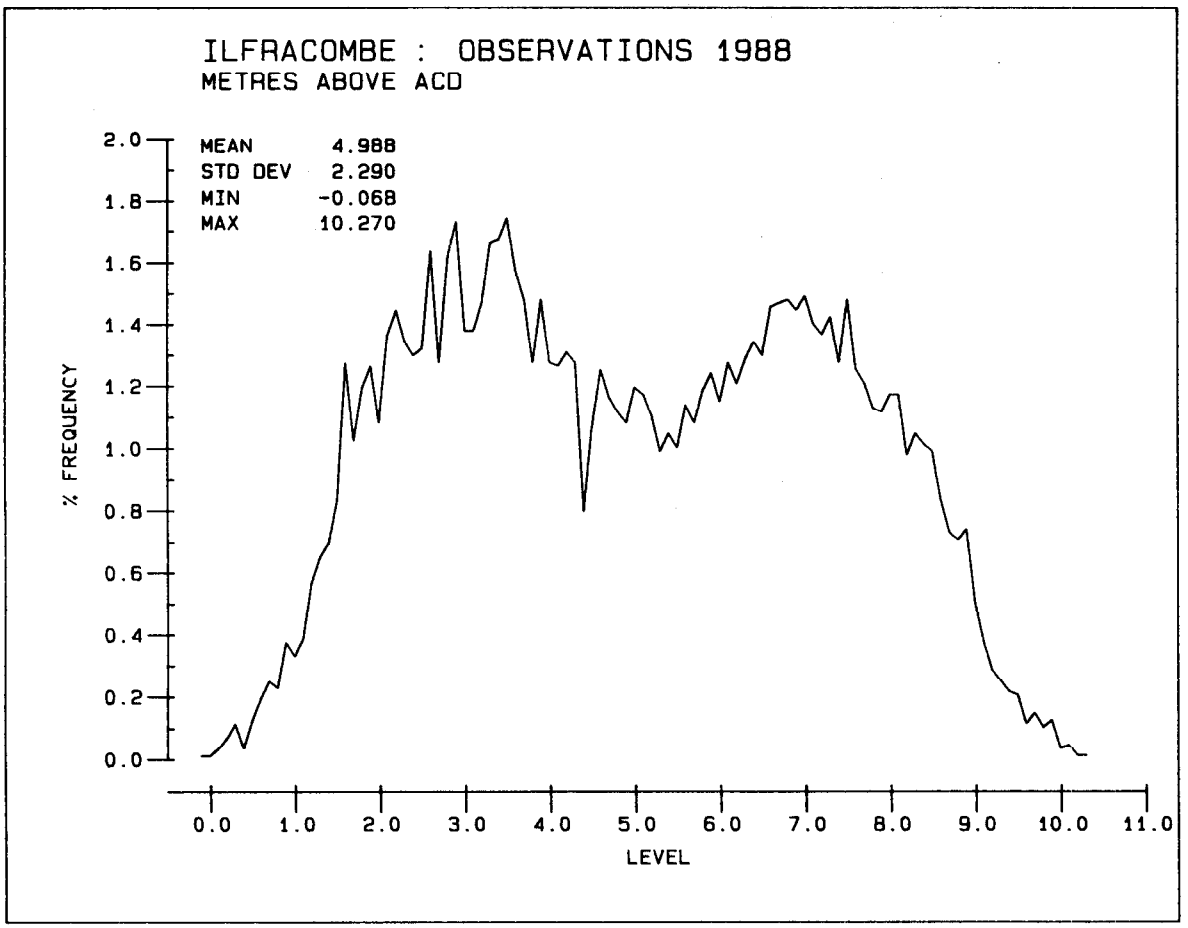
The primary, Class-A, channel on a pressure system furnished with a digiquartz sensor (Channel 2) with a back-up potentiometer connected to the stilling well float gear have been interrogated via the Dataring system since June 1983.

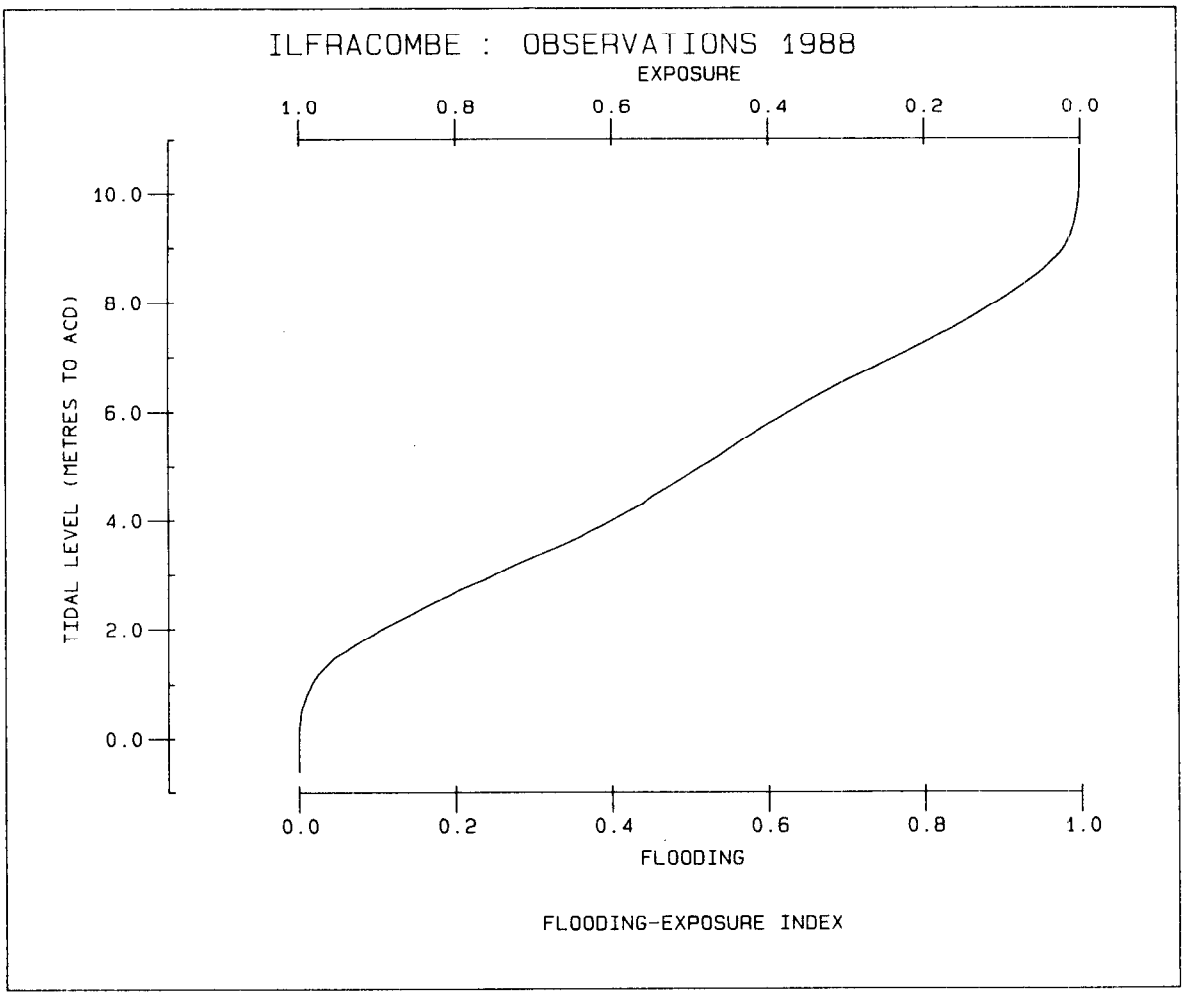
Filtering of Channel 1 data from the stilling well has continued alongside the data from the pressure system to provide additional information about conditions in the Severn estuary.

Prior to filtering to hourly levels, isolated missing scans were interpolated in the raw data on the following dates: 12,13 and 27 April,June 28,July 10, November 21 and December 5.

Gaps in values filtered for 1988
.....

Nil gaps.


ILFRACOMBE : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 4.988
STD DEV 2.290
MIN -0.068
MAX 10.270
% FREQUENCY
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0
LEVEL


ILFRACOMBE : OBSERVATIONS 1988
EXPOSURE
1.0 0.8 0.6 0.4 0.2 0.0
TIDAL LEVEL (METRES TO ACD)
10.0
8.0
6.0
4.0
2.0
0.0
0.0 0.2 0.4 0.6 0.8 1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, WEST COAST - ILFRACOMBE

LATITUDE: 51 13' N

LONGITUDE: 4 07' W

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 4.988

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 4.80 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.4989D+01 RESIDUAL MEAN = 0.1212D-05
STD DEV = 0.2291D+01 STD DEV = 0.1508D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.025 | 296.65 |
| O1 | 0.066 | 348.29 |
| P1 | 0.024 | 115.09 |
| K1 | 0.065 | 124.85 |
| J1 | 0.005 | 247.47 |
| 2N2 | 0.083 | 119.87 |
| N2 | 0.575 | 143.20 |
| M2 | 3.042 | 161.86 |
| S2 | 1.116 | 208.43 |
| K2 | 0.322 | 206.51 |
| M3 | 0.030 | 129.89 |
| M4 | 0.108 | 350.75 |
| MS4 | 0.062 | 53.53 |
| M6 | 0.020 | 339.53 |

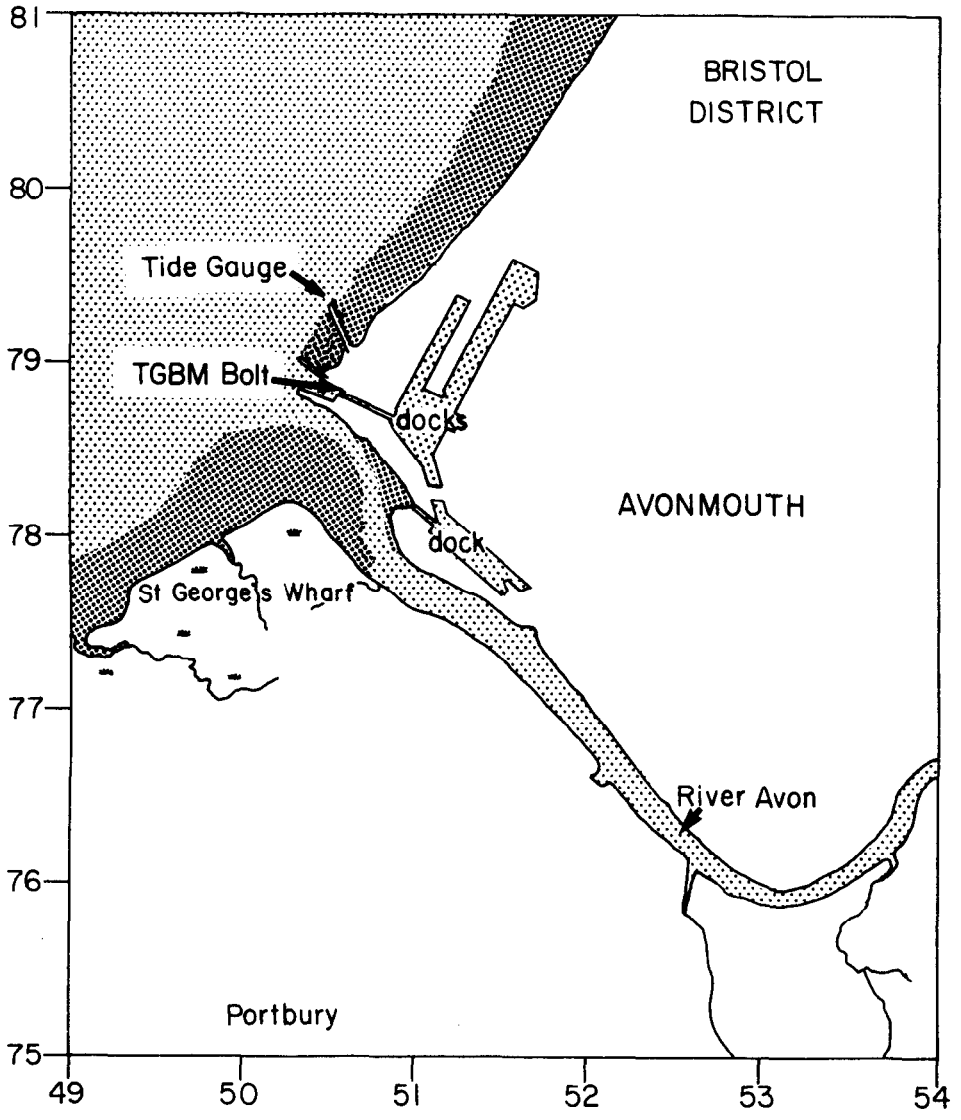
2.3 AVONMOUTH

Latitude 51 deg 30'N Longitude 02 deg 43'W

National Grid reference ST5045 7933

Recording zero = Chart Datum = 6.5m below Ordnance Datum Newlyn

Recording zero = 15.711m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | ST50577881 | OSBM Bolt at base of bollard |
| Aux 1 | ST50727859 | Rivet adj. transit shed NW face W angle |
| Aux2 | ST50637898 | Rivet base building NW side S angle |
| Aux3 | ST50917927 | Rivet MHC surr. S side road 1·8m N angle building. |

Data processing
.....

Two digiquartz sensors on pressure systems have been interrogated since September 1986, with a largely experimental long-tubed channel (Channel 2, back-up) and a 'short-leg' Channel 1 treated as the Class-A channel.

Missing scans were interpolated in the raw data prior to filtering to hourly heights on the following dates : Feb 14,18, Apr 17, May 5,16, Jun 2,28, Jul 21, Aug 16, Sep 16,23, Oct 19,24 and Nov 22.

Gaps in Channel 1 data
.....

1200 GMT 4 March to 1800 GMT 10 March Compressor failure

1900 GMT 12 April to 2100 GMT 14 April Compressor turned off during routine visit by Tide Gauge Inspectorate.

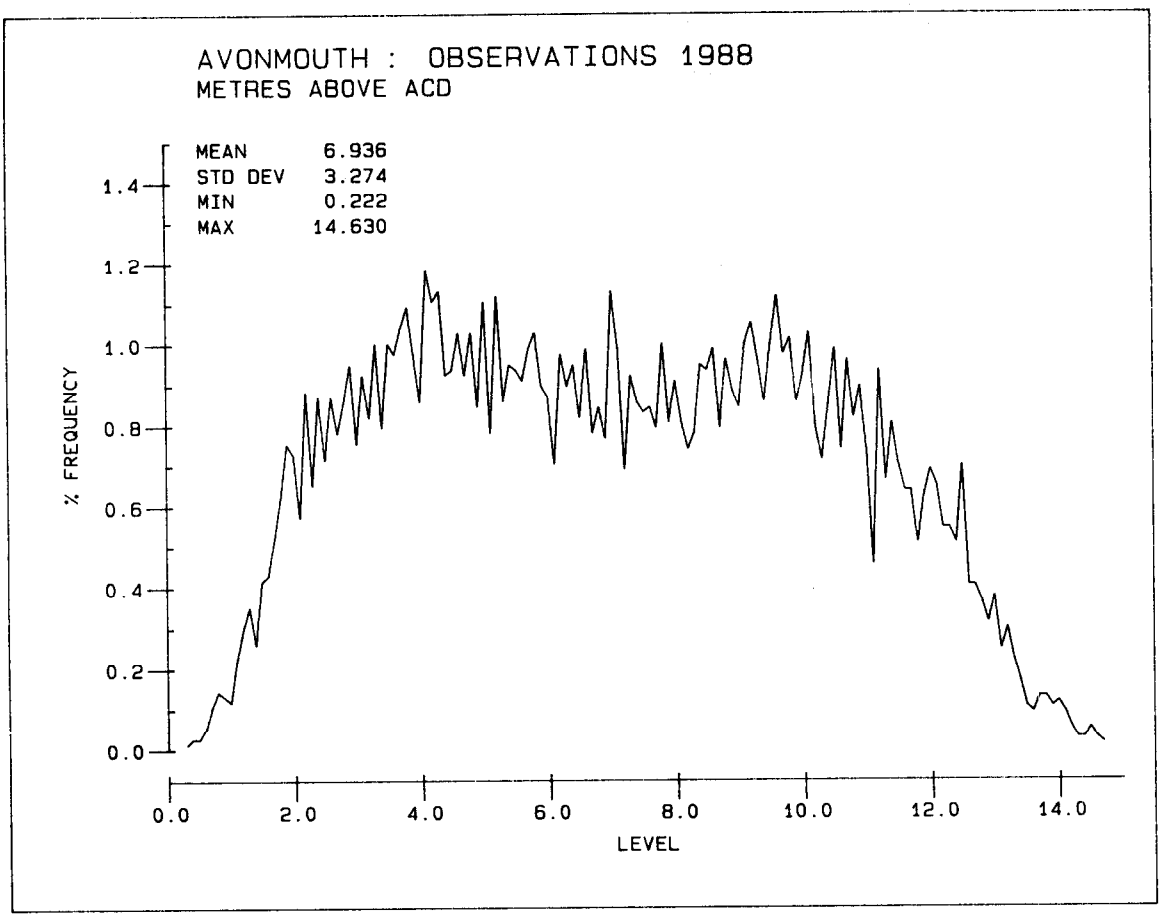
2000 GMT 24 November to end of year. Compressor failure*

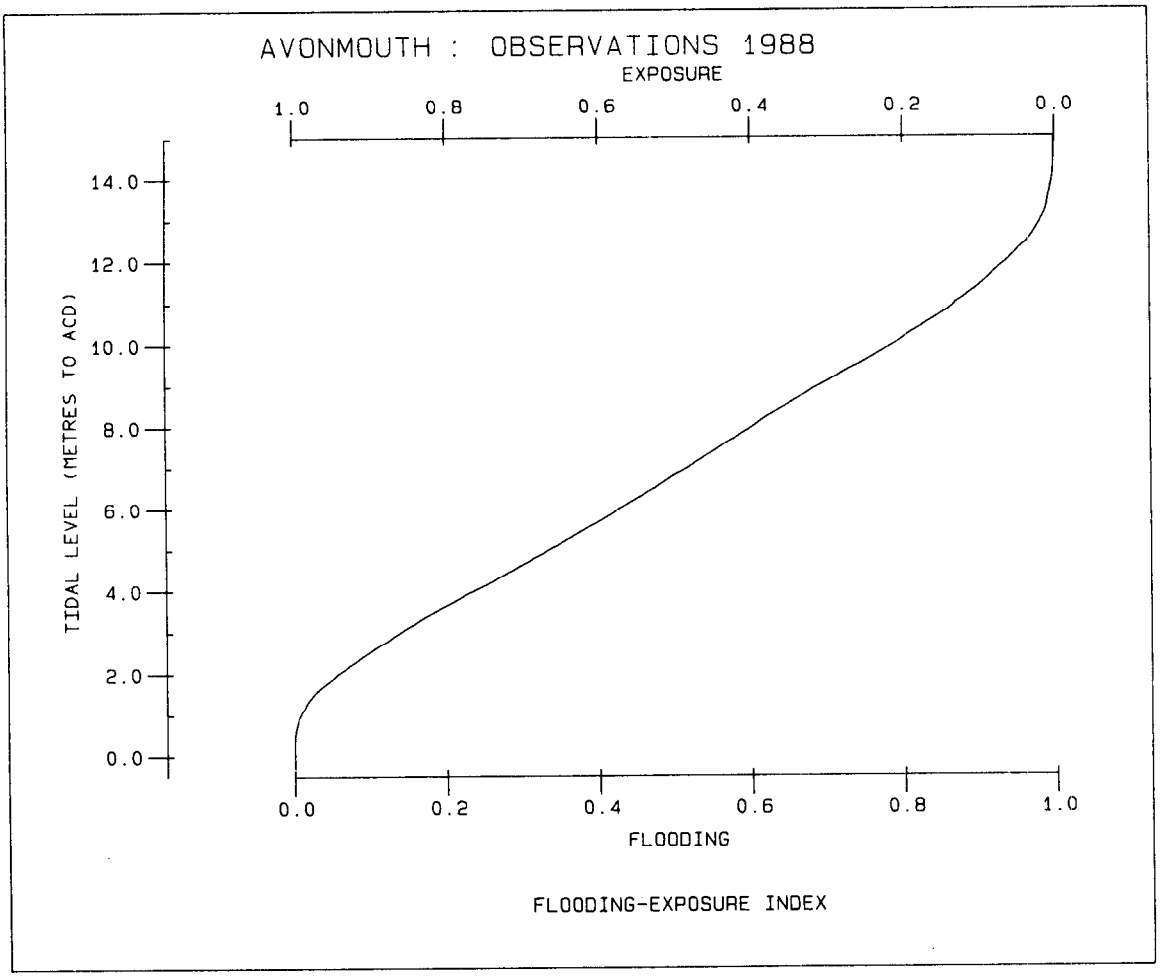
*Originally it was believed that land reclamation work in the area had in some way interfered with the pressure tube system but a subsequent visit by TGI in early 1989 proved that all lines were in fact intact and that it was a compressor fault. In the interim, marine growth had become a problem.

Site diary
.....

12 to 14 April TGI visit to clear the blocked line at the pressure point for Channel 2 (back-up).

October Excavation work in progress in close proximity to gauge site.


AVONMOUTH : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 6.936
STD DEV 3.274
MIN 0.222
MAX 14.630
% FREQUENCY
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
LEVEL


AVONMOUTH : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, WEST COAST - PORT OF BRISTOL (AVONMOUTH)

LATITUDE: 51 30' N

LONGITUDE: 2 43' W

TIME ZONE: GMT

LENGTH: 355 DAYS

FROM: 15TH NOVEMBER, 1987 TO: 23RD NOVEMBER, 1988

UNITS: METRES A0: 6.942

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 6.50 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.6945D+01 RESIDUAL MEAN = 0.2430D-06
STD DEV = 0.3265D+01 STD DEV = 0.2238D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.029 | 316.27 |
| O1 | 0.074 | 4.68 |
| P1 | 0.032 | 138.09 |
| K1 | 0.069 | 144.40 |
| J1 | 0.008 | 284.56 |
| 2N2 | 0.096 | 171.40 |
| N2 | 0.751 | 184.57 |
| M2 | 4.303 | 199.89 |
| S2 | 1.542 | 258.47 |
| K2 | 0.452 | 255.13 |
| M3 | 0.050 | 216.25 |
| M4 | 0.251 | 348.13 |
| MS4 | 0.228 | 17.47 |
| M6 | 0.124 | 271.08 |

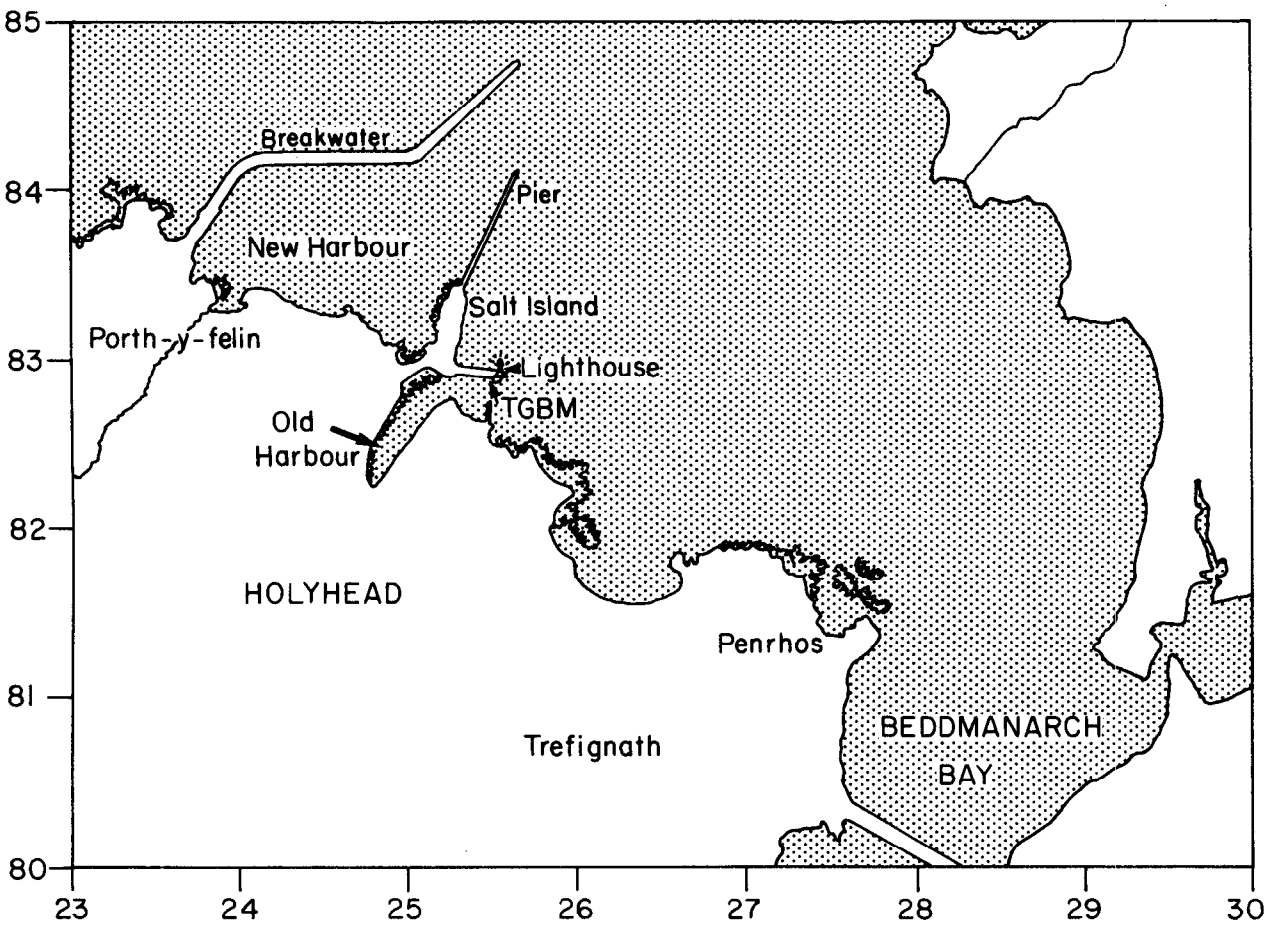
2.4 HOLYHEAD

Latitude 53 deg 18' 27.1"N Longitude 04 deg 37' 48.0"W

National Grid reference SH 2553 8287

Recording zero = Chart Datum = 3.05m below Ordnance Datum Newlyn

Recording zero = 7.447m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | SH25538287 | Bolt concrete foundation N side TG building |
| Aux1 | SH25568289 | PA bolt harbour lighthouse S face |
| Aux2 | SH25538286 | TG rivet conc. foundation E side ent. TG bldg. |
| Aux3 | SH25068292 | Bolt Salt Is. bridge 2·2m S junction walls |

Data processing
.....

The primary channel on a pressure system with digiquartz sensor (Channel 2) and a back-up potentiometer connected to the Munro gauge (Channel 1) in a stilling well have been interrogated via the Dataring system since August 1984.

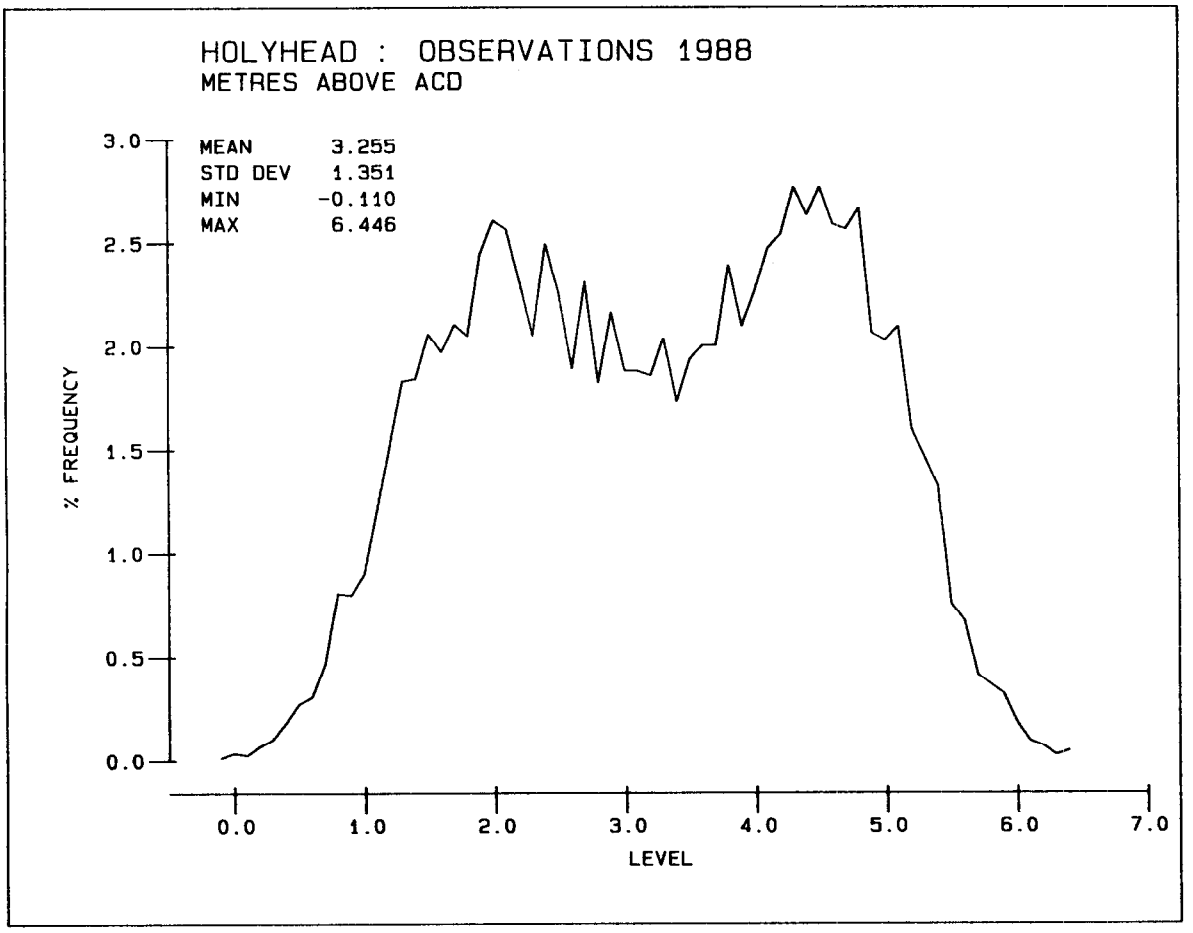
Before filtering to hourly levels, isolated missing scans in the raw data were interpolated on the following dates : Jan 9,23, Mar 21, Jun 1,28, Aug 13,27, Sep 25, Nov 22.

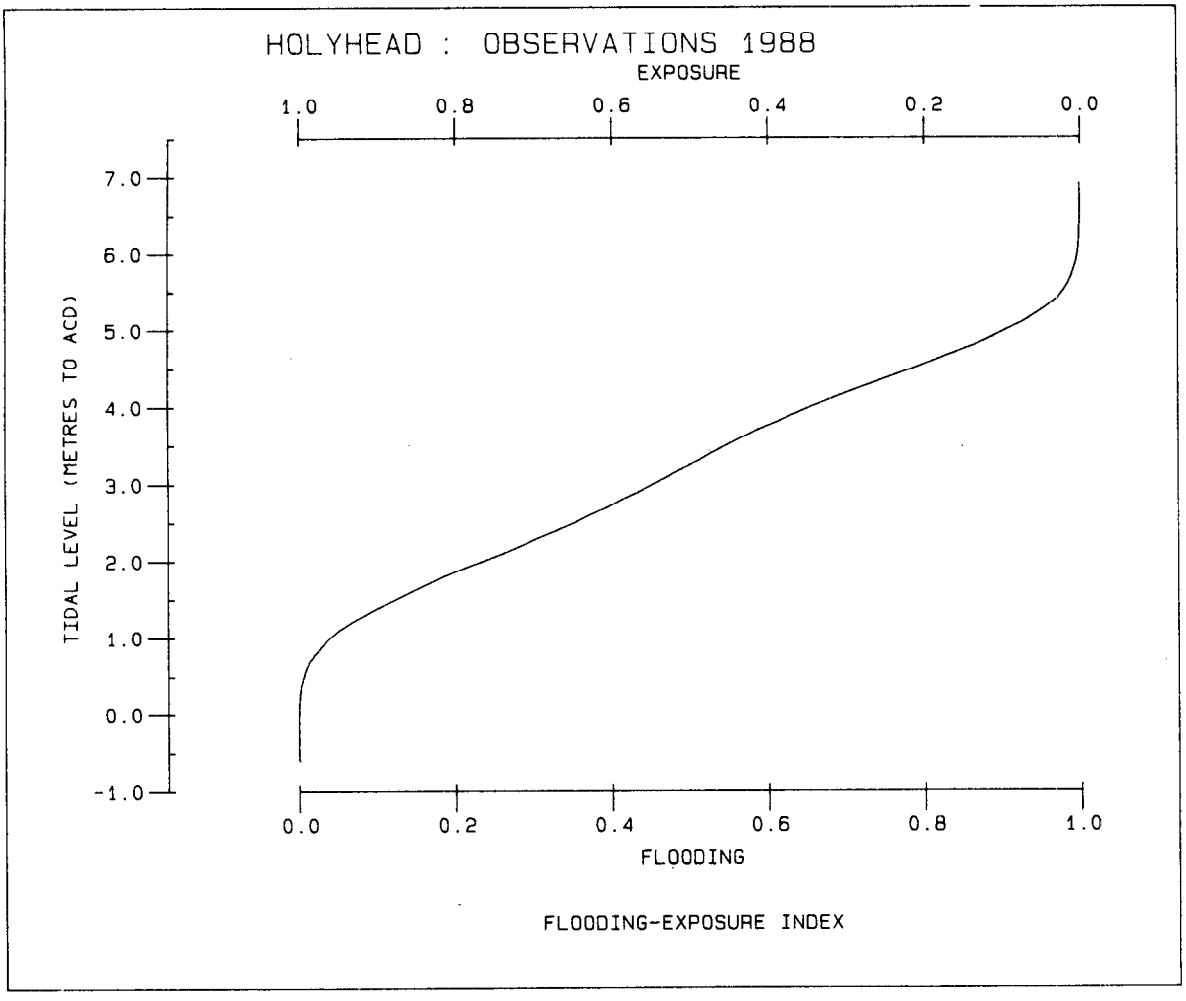
Gaps in filtered data from Channel 2
.....

Nil gaps.

Site diary.
.....

27 June TGI visit to replace 'power unit' and raise the datum on the Munro gauge (Dataring system unaffected).


HOLYHEAD : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 3.255
STD DEV 1.351
MIN -0.110
MAX 6.446
% FREQUENCY
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
LEVEL


HOLYHEAD : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: WALES - HOLYHEAD

LATITUDE: 53 18' 27.1" N

LONGITUDE: 4 37' 48.0" W

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 3.257

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 3.05 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.3257D+01 RESIDUAL MEAN = 0.5510D-06
STD DEV = 0.1353D+01 STD DEV = 0.1641D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.039 | 331.99 |
| O1 | 0.099 | 29.45 |
| P1 | 0.038 | 166.68 |
| K1 | 0.102 | 177.66 |
| J1 | 0.009 | 282.89 |
| 2N2 | 0.049 | 243.20 |
| N2 | 0.363 | 267.88 |
| M2 | 1.803 | 292.03 |
| S2 | 0.594 | 328.82 |
| K2 | 0.169 | 327.17 |
| M3 | 0.019 | 243.17 |
| M4 | 0.035 | 26.69 |
| MS4 | 0.013 | 47.19 |
| M6 | 0.022 | 224.37 |

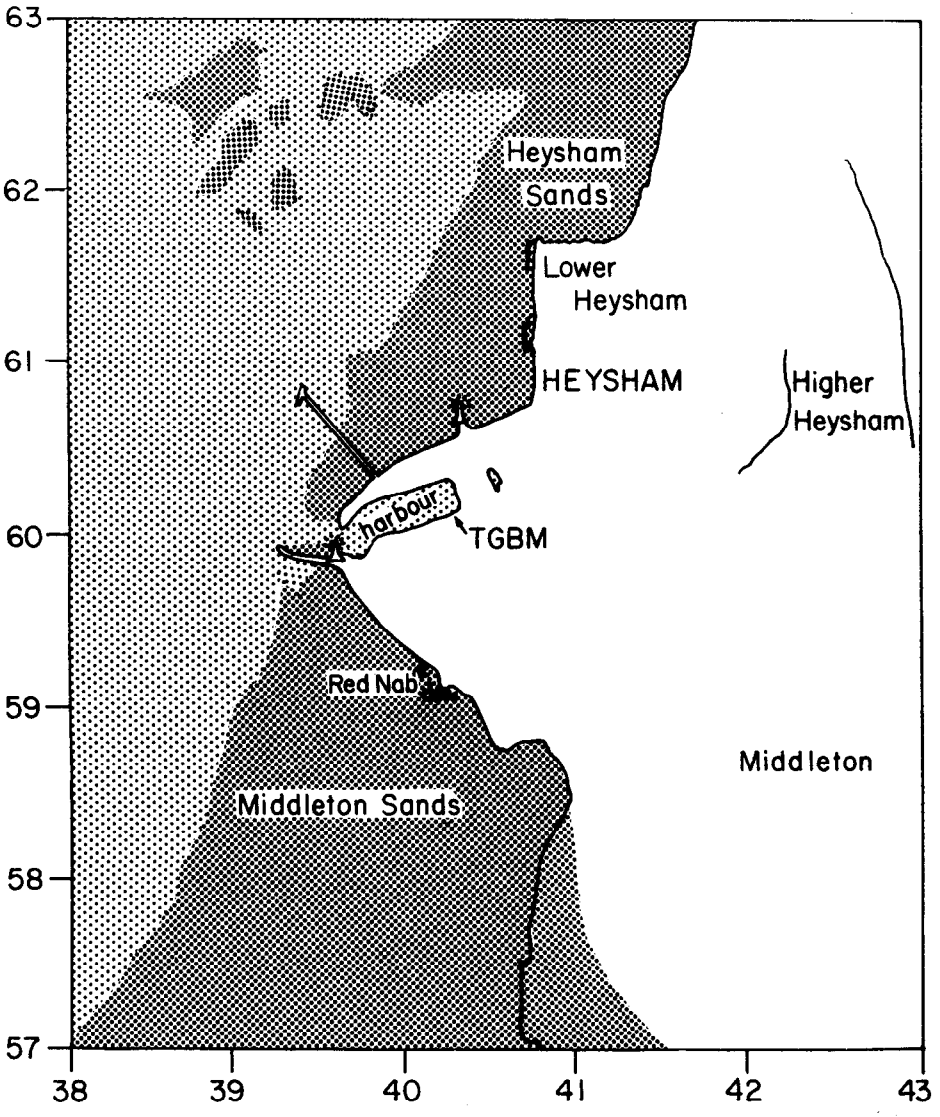
2.5 HEYSHAM

Latitude 54 deg 02' 0.3"N Longitude 02 deg 54' 42.3"W

National Grid reference SD 4030 6012

Recording zero = Chart Datum = 4.9m below Ordnance Datum Newlyn

Recording zero = 12.095m below Tide Gauge Bench Mark




| Bench Marks | NG Co-ords | Description |
|---|---|---|
| TGBM | SD40306012 | OSBM Bolt S quay 40·8m SW angle dock |
| Aux1 | SD41416005 | Bridge parapet 3·4m N face junction E side road W face |
| Aux2 | SD40266033 | Pivot pin harbour wall 6·1m SW N angle harbour. |
| Aux3 | SD40266033 | Rivet harbour wall 30·5m NE SW end North Wharf. |

Data processing
.....

Two pressure point systems with digiquartz sensors have been interrogated since November 1987.

Channel 2 has been designated as the primary Class-A channel.

Isolated missing scans were interpolated in the raw data on the following dates : Feb 15, Mar 31, Apr 6,15, Aug 27, Oct 25.

Numerous spurious values on 14 June were edited.

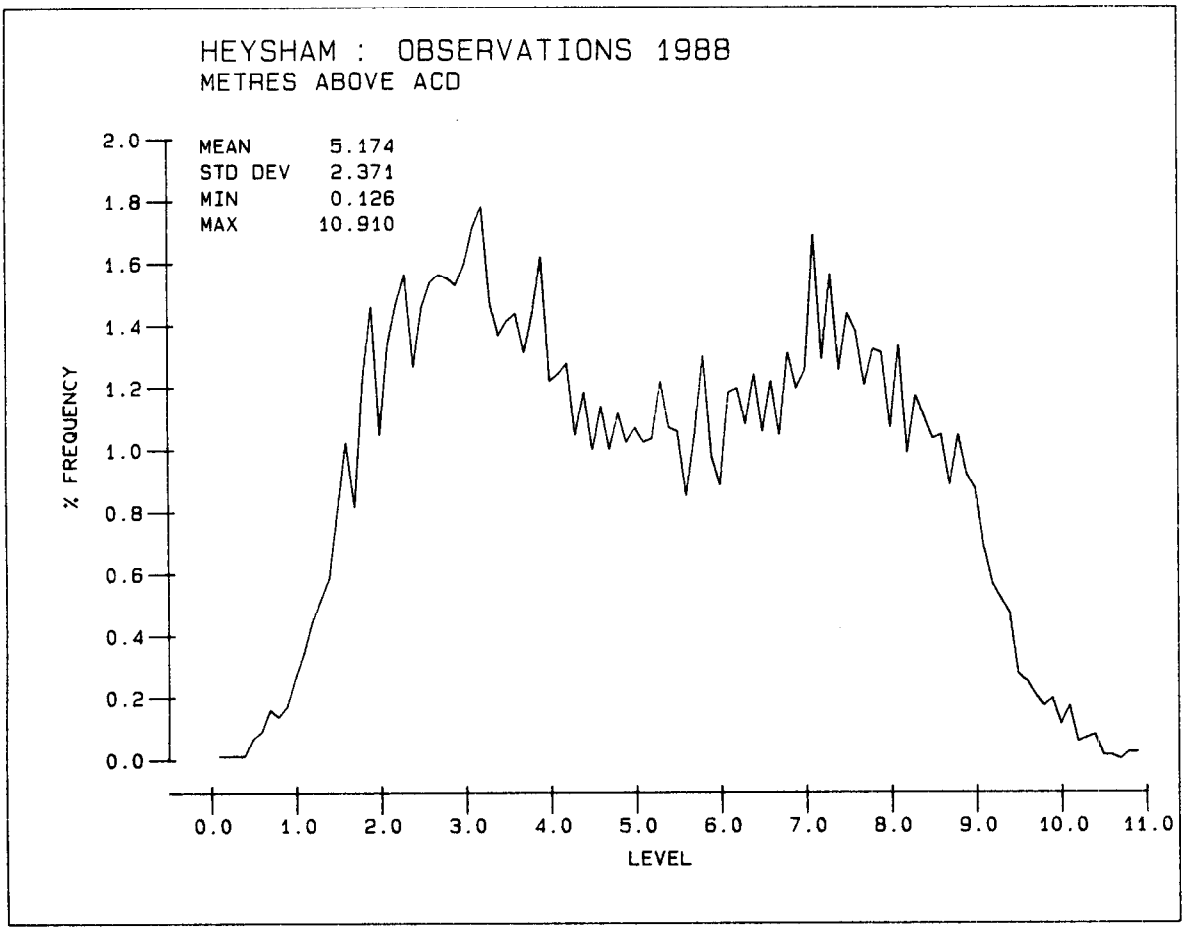
Gaps in filtered data from Channel 2
.....

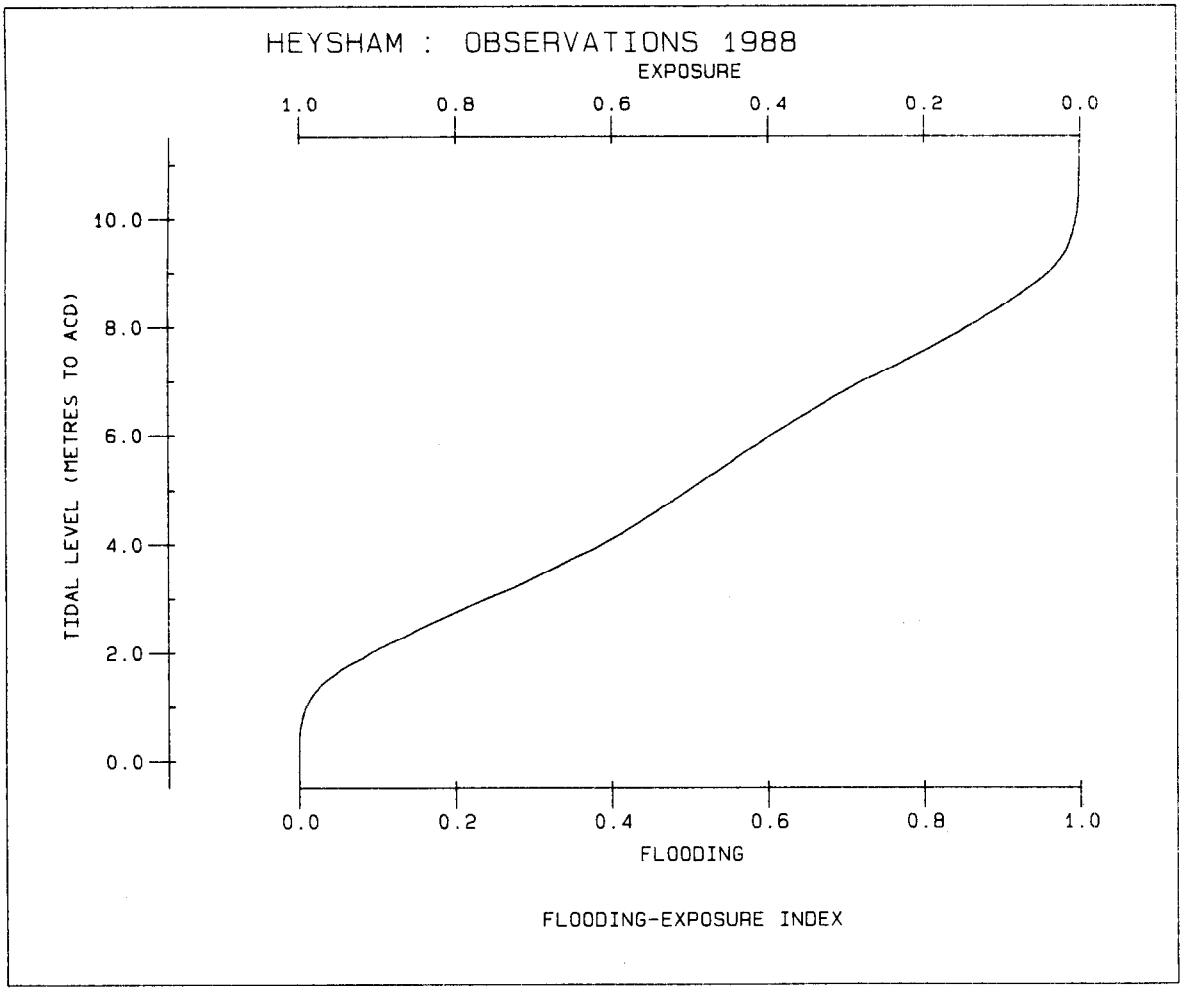
0600 GMT 8 July to 1600 GMT 11 July : Compressor fault

Site diary
.....

8 July TGI visit for routine maintenance.Fault found on compressor.

11 July TGI visit to fit new compressor and adjust clock.


HEYSHAM : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 5.174
STD DEV 2.371
MIN 0.126
MAX 10.910
% FREQUENCY
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0
LEVEL


HEYSHAM : OBSERVATIONS 1988
EXPOSURE
1.0 0.8 0.6 0.4 0.2 0.0
TIDAL LEVEL (METRES TO ACD)
10.0
8.0
6.0
4.0
2.0
0.0
0.0 0.2 0.4 0.6 0.8 1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, WEST COAST - HEYSHAM

LATITUDE: 54 02' N

LONGITUDE: 2 55' W

TIME ZONE: GMT

LENGTH: 362 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 5.175

HOURLY DATA FROM DIGIQUARTZ GAUGE 2

DATUM OF OBSERVATIONS = ACD : 4.90 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.5175D+01 RESIDUAL MEAN = 0.1060D-05
STD DEV = 0.2373D+01 STD DEV = 0.2232D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.041 | 340.62 |
| O1 | 0.109 | 43.75 |
| P1 | 0.044 | 181.93 |
| K1 | 0.117 | 194.39 |
| J1 | 0.011 | 293.01 |
| 2N2 | 0.081 | 280.10 |
| N2 | 0.615 | 301.81 |
| M2 | 3.176 | 325.58 |
| S2 | 1.040 | 8.31 |
| K2 | 0.294 | 6.96 |
| M3 | 0.034 | 308.77 |
| M4 | 0.201 | 246.06 |
| MS4 | 0.118 | 297.35 |
| M6 | 0.018 | 39.28 |

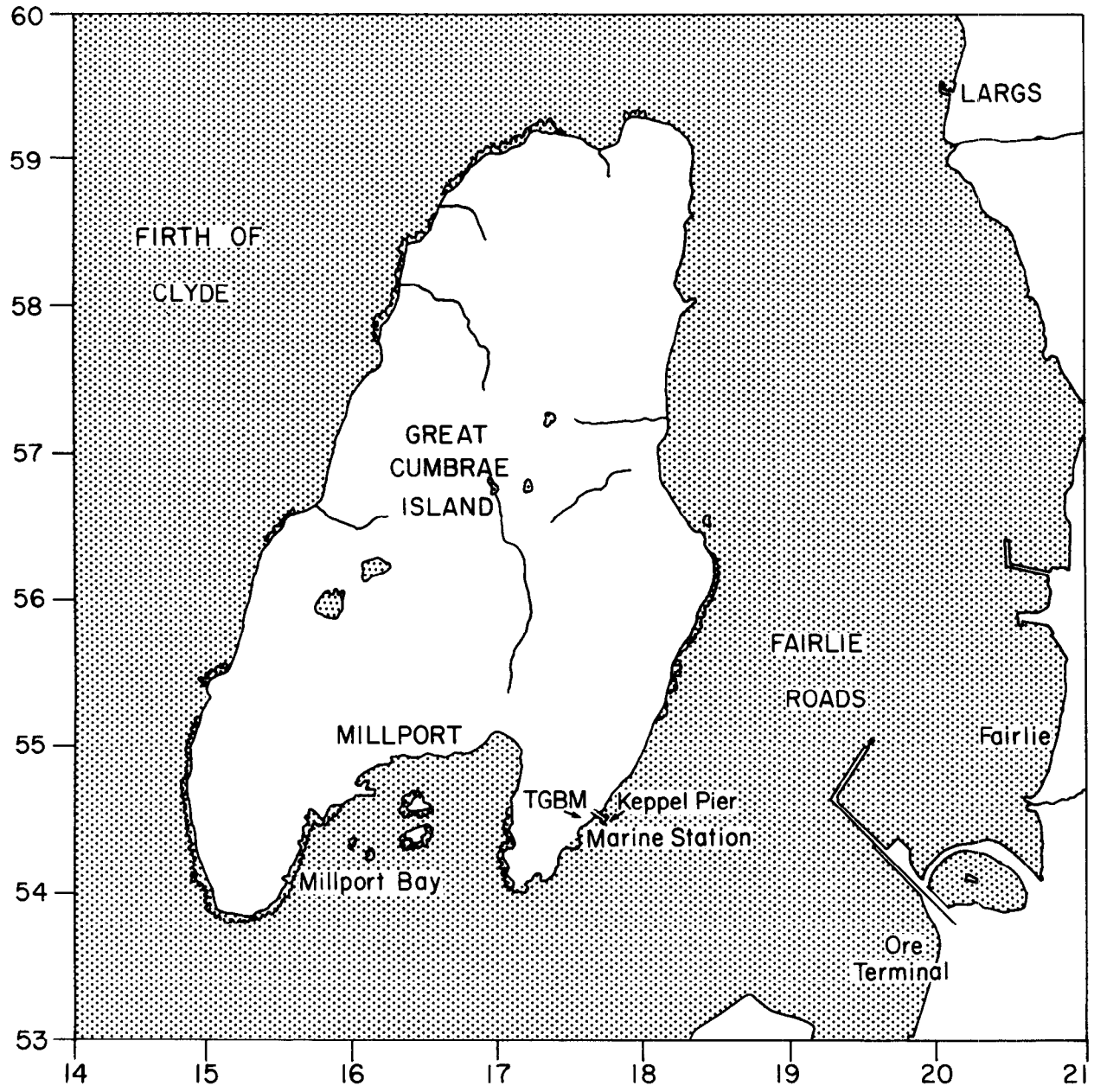
2.6 MILLPORT

Latitude 55 deg 45' 0.0"N Longitude 04 deg 54' 15.0"W

National Grid reference NS 1770 5450

Recording zero = Chart Datum = 1.62m below Ordnance Datum Newlyn

Recording zero = 7.825m below Tide Gauge Bench Mark




| Bench Marks | NG Co-ords | Description |
|---|---|---|
| TGBM | NSI7575449 | Flush bracket G4602 Marine Station |
| Aux1 | NSI7715457 | OSBM bolt rock SE side road 5m NE end W |
| Aux2 | NSI7695454 | Rivet pier 0·8m production SE face TG building. |
| Aux3 | NSI7185451 | No45 Marine Parade NW angle N face |

Data processing
.....

The tide gauge site on Keppel Pier was modernised to accomodate the Dataring system in March 1985 with the primary,Class-A channel from a pressure point with digiquartz sensor.The secondary channel is a potentiometer linkage to the Ott pneumatic gauge.

Prior to filtering to hourly data, raw values were interpolated as follows :

Jan 17, Mar 23, Apr 5,7,14,15,17,30, Jul 6,7, Nov 30, Dec 1.

Many extra scans and spurious values on 19 April , coinciding with the visit by Tide Gauge Inspectorate, were edited to minimise the gaps in the data.

Gaps in filtered data from primary channel (Channel 2 )
.....

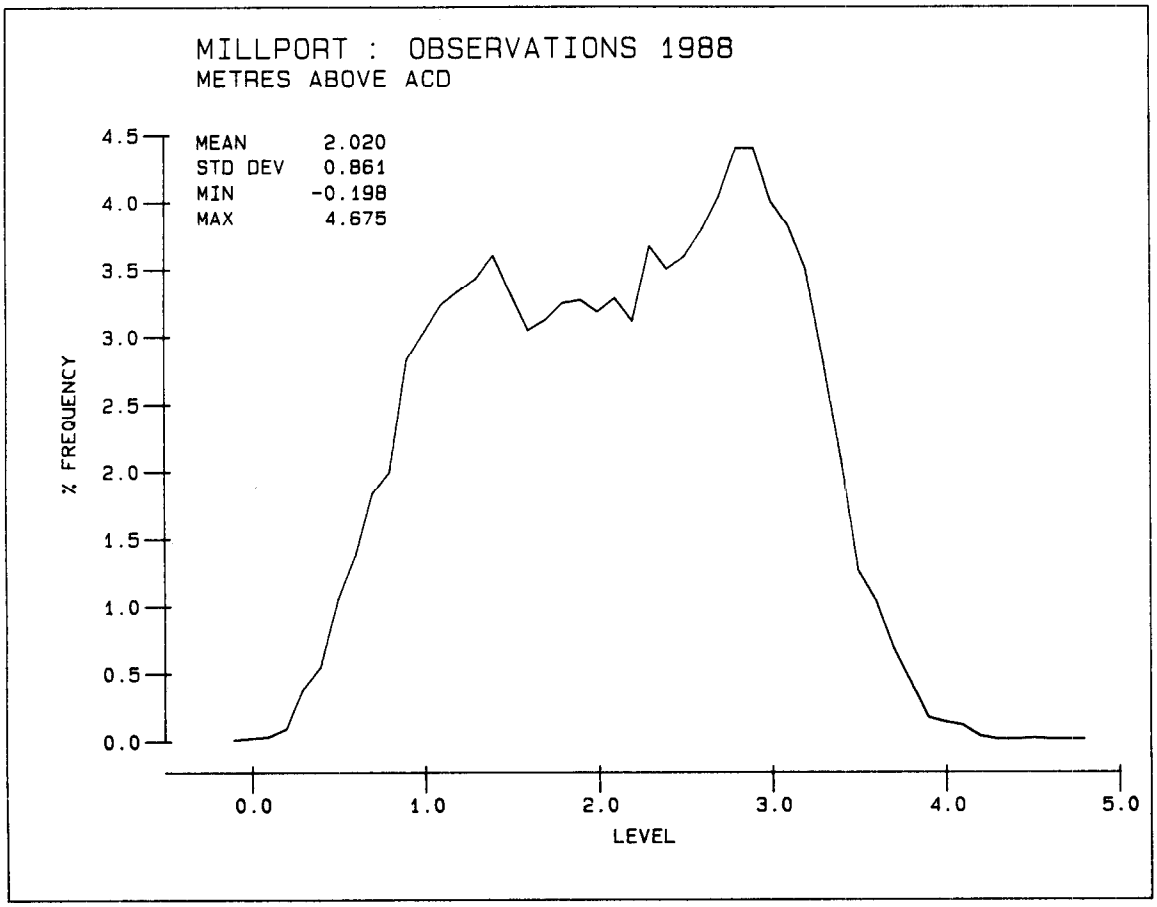
0600 GMT 6 July to 2100 GMT 6 July : Coinciding with TGI visit.

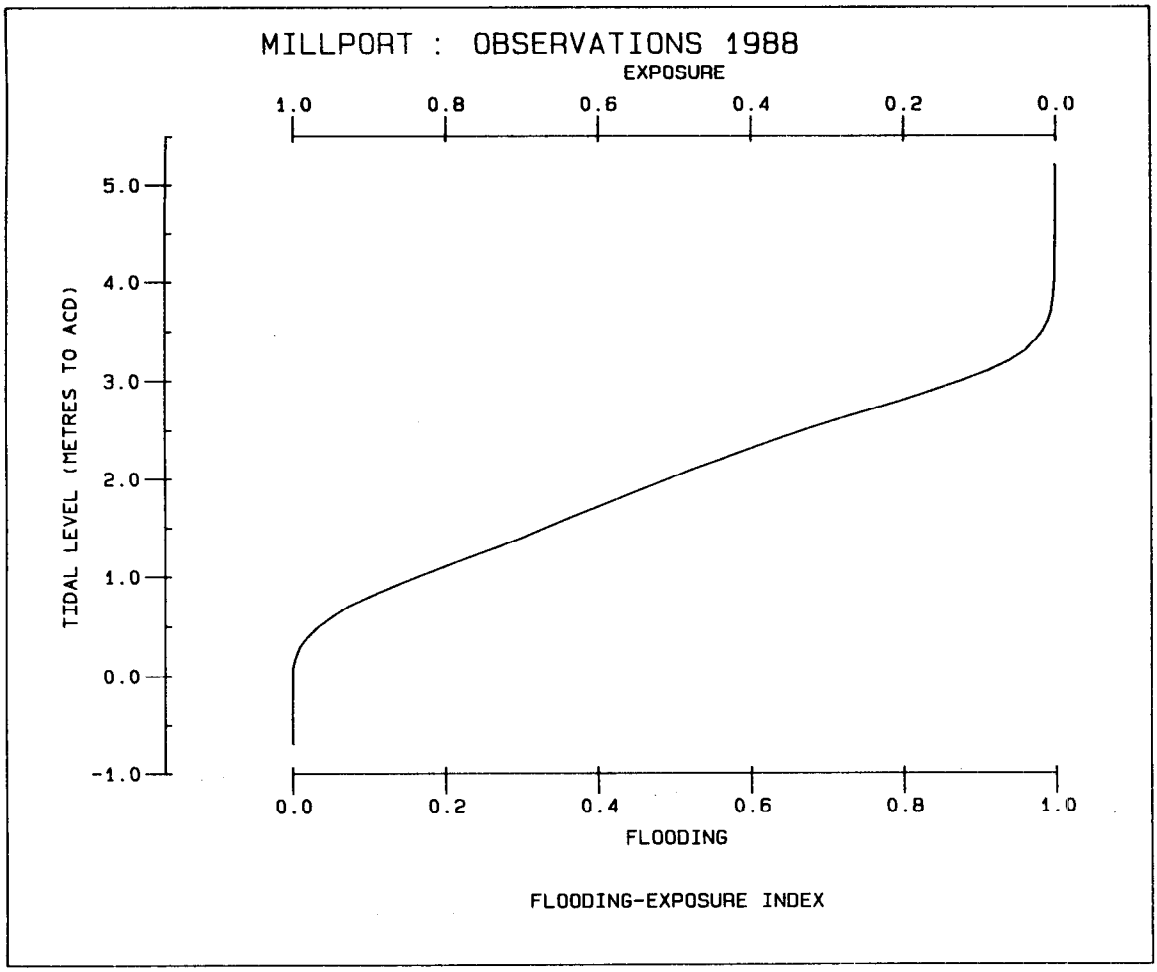
Site diary
.....

19 April TGI visit. All equipment checked.

6 July TGI visit. Calibrations checked and revised parameters for Latitude incorporated in the system.

Repairs to Channel 1 pressure system.


MILLPORT : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 2.020
STD DEV 0.861
MIN -0.198
MAX 4.675
% FREQUENCY
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
LEVEL


MILLPORT : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, WEST COAST - MILLPORT

LATITUDE: 55 45' 00.0" N

LONGITUDE: 4 54' 15.0" W

TIME ZONE: GMT

LENGTH: 365 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 2.021

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 1.62 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.2022D+01 RESIDUAL MEAN = 0.5247D-06
STD DEV = 0.8594D+00 STD DEV = 0.2035D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.037 | 343.01 |
| O1 | 0.097 | 44.20 |
| P1 | 0.038 | 182.97 |
| K1 | 0.106 | 194.56 |
| J1 | 0.009 | 292.28 |
| 2N2 | 0.029 | 288.94 |
| N2 | 0.215 | 315.42 |
| M2 | 1.121 | 342.57 |
| S2 | 0.299 | 34.85 |
| K2 | 0.086 | 34.48 |
| M3 | 0.049 | 105.08 |
| M4 | 0.088 | 91.87 |
| MS4 | 0.089 | 119.92 |
| M6 | 0.024 | 302.46 |

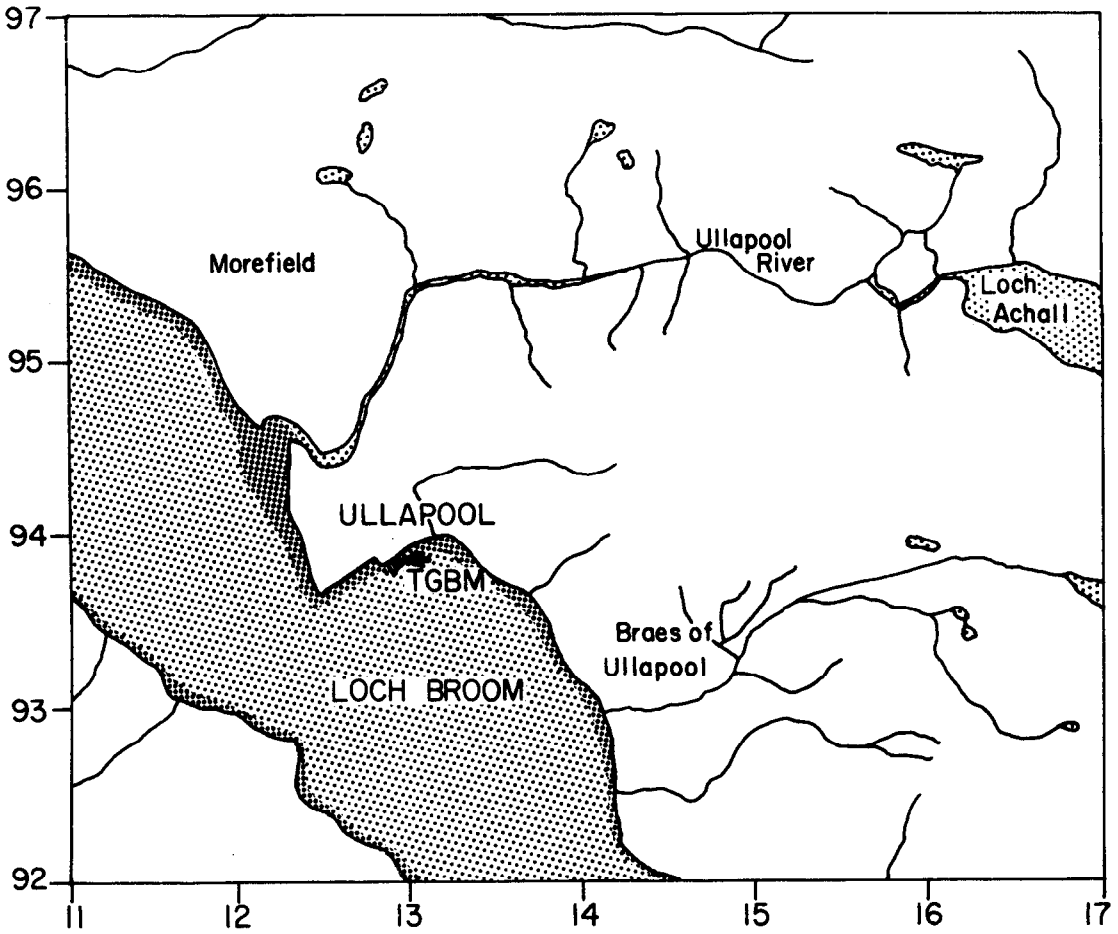
2.7 ULLAPOOL

Latitude 57 deg 53' 44.7"N Longitude 05 deg 10' 27.0"W

National Grid reference NH 1288 9391

Recording zero = Chart Datum = 2.75m below Ordnance Datum Newlyn

Recording zero = 7.155m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | NH12889391 | OSBM pier NW parapet 8·2m NE steps. |
| Aux1 | NH13039425 | PA bolt church SW side road NE face N angle. |
| Aux2 | NH12889398 | No.8 Shore St. SE face 0·3m S angle. |
| Aux3 | NH12539376 | Rivet foundation No.21 West Shore St. S. angle. |

## Data processing

The modernised system linked to Dataring has been accessed since May 1987. The Class-A channel (Channel 2) is furnished with a digiquartz sensor on a pressure gauge system with a back-up potentiometer connected to the Munro gauge in the stilling well.

Missing scans in the raw data were interpolated on the following dates : Apr 18, Jun 7, Sep 23, Nov 4.

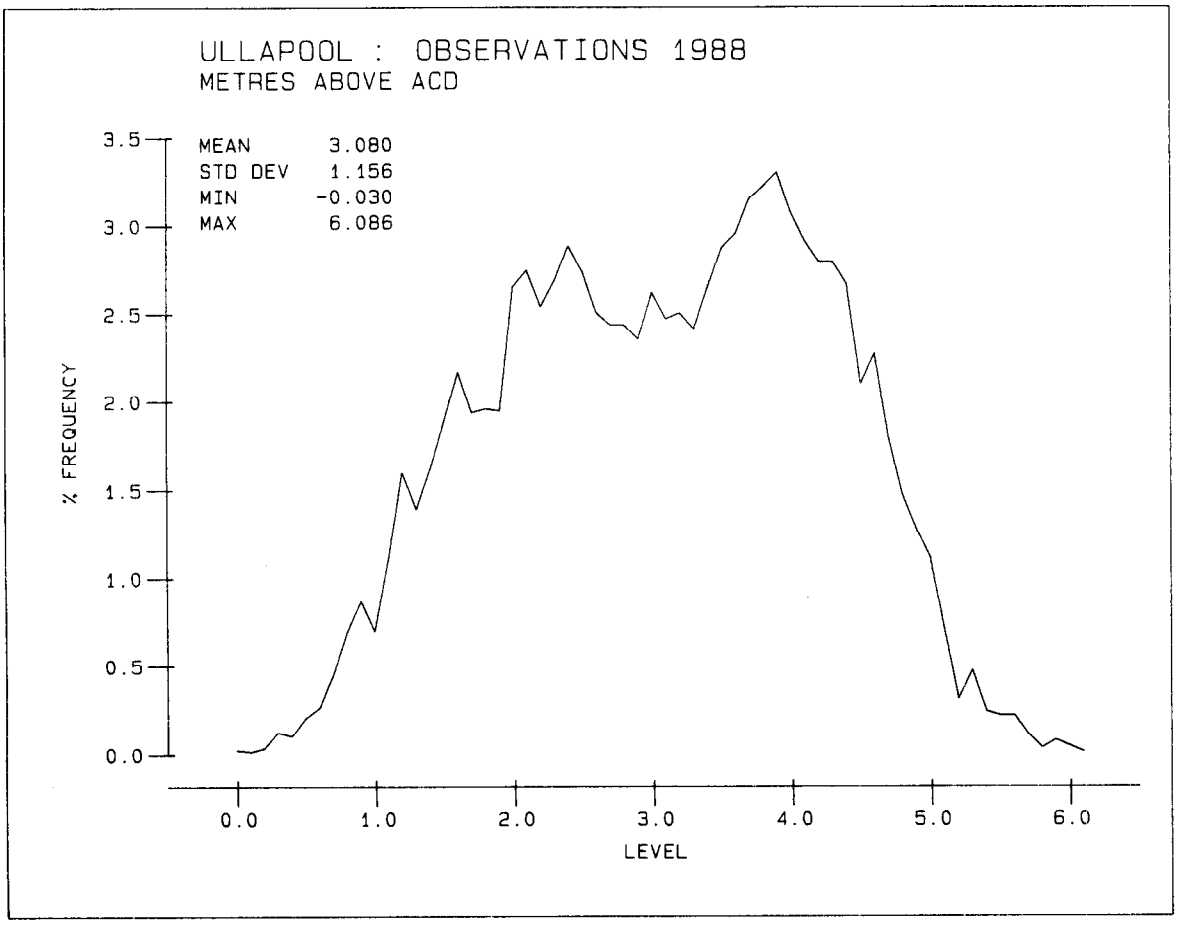
## Gaps in filtered values from digiquartz sensor

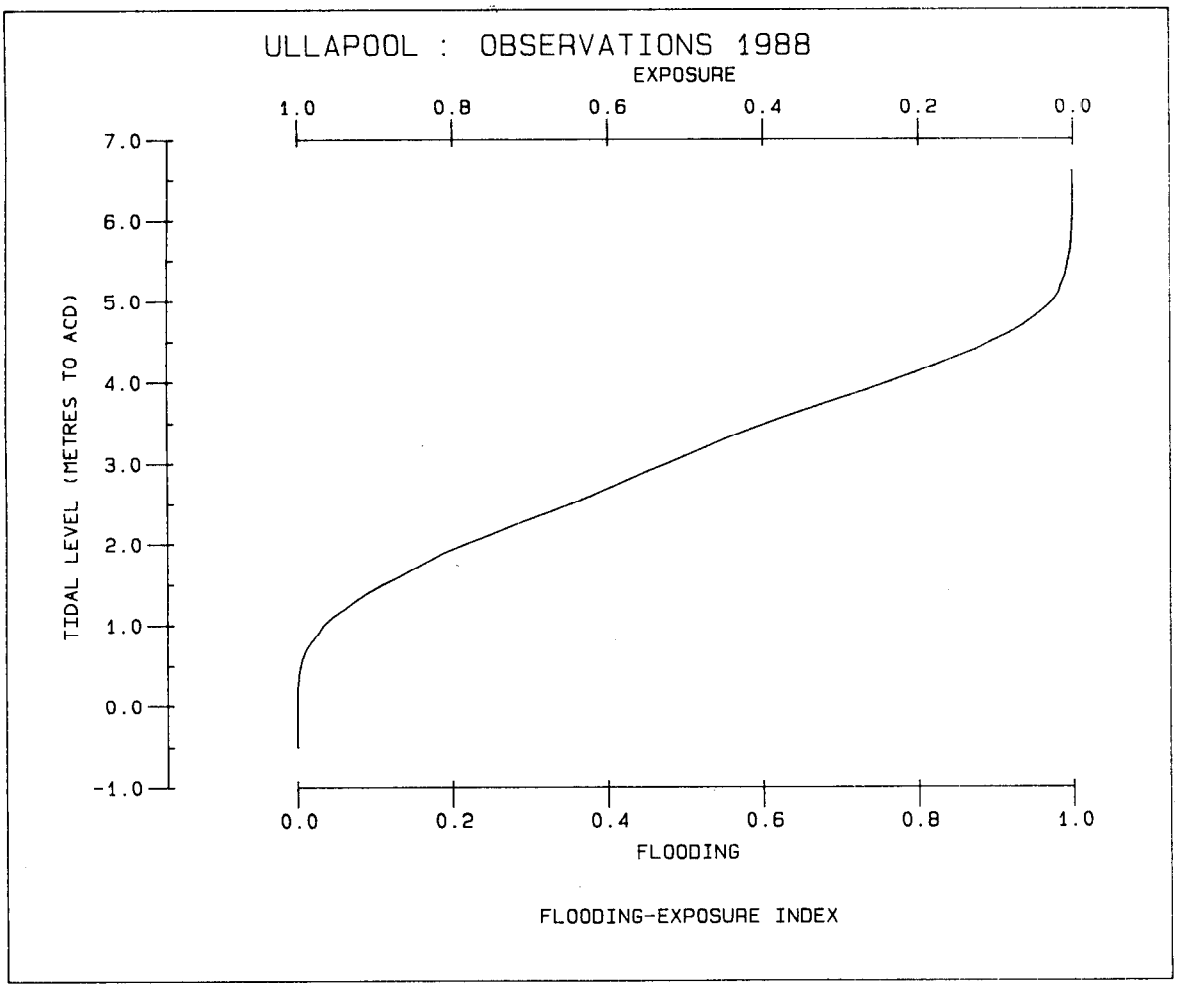
0001 GMT 1 January to 2000 GMT 6 January : Modem fault

0400 GMT 19 July to 2000 GMT 19 July : Coinciding with TGI visit.

## Site diary

| | | |
|---|---|---|
| 6 to 7 | January | TGI visit.New clock card and modem fitted. Channel 1 (potentiometer) recalibrated. |
| 19 | July | TGI visit. Routine maintenance.Channel 2 recalibrated and and parameters for Latitude reset. |


ULLAPOOL : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 3.080
STD DEV 1.156
MIN -0.030
MAX 6.086
% FREQUENCY
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
LEVEL


ULLAPOOL : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: SCOTLAND, WEST COAST - ULLAPOOL

LATITUDE: 57 54' N

LONGITUDE: 5 10' W

TIME ZONE: GMT

LENGTH: 359 DAYS

FROM: 6TH JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 3.083

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 2.75 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.3082D+01 RESIDUAL MEAN = 0.3451D-06
STD DEV = 0.1156D+01 STD DEV = 0.1663D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.031 | 300.28 |
| O1 | 0.076 | 343.50 |
| P1 | 0.032 | 112.28 |
| K1 | 0.107 | 129.55 |
| J1 | 0.006 | 203.96 |
| 2N2 | 0.038 | 152.79 |
| N2 | 0.305 | 179.36 |
| M2 | 1.495 | 200.70 |
| S2 | 0.585 | 234.64 |
| K2 | 0.167 | 232.66 |
| M3 | 0.027 | 125.00 |
| M4 | 0.064 | 230.34 |
| MS4 | 0.076 | 304.22 |
| M6 | 0.007 | 198.18 |

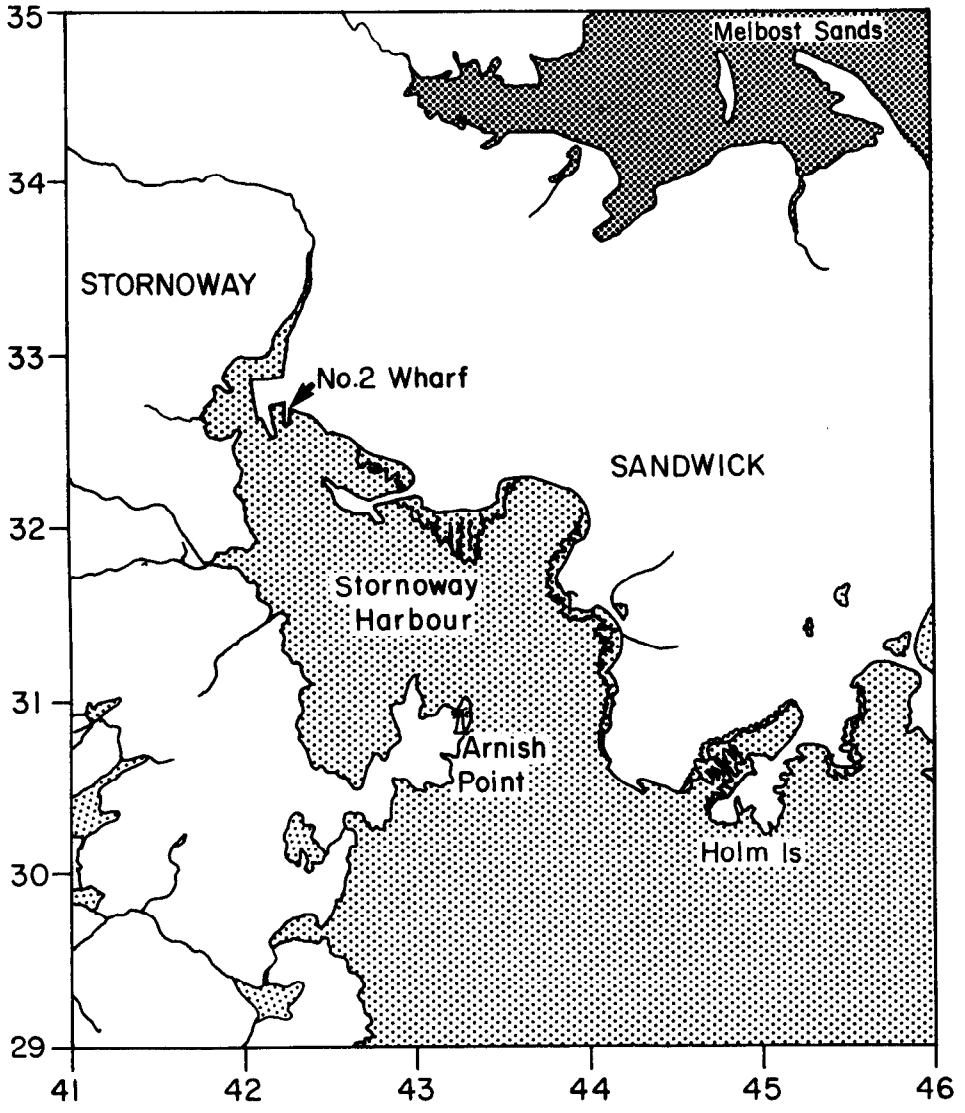
2.8 STORNOWAY

Latitude 58 deg 12' 0.0"N Longitude 06 deg 23' 0.0"W

National Grid reference NB 4226 3271

Recording zero = Chart Datum = 2.71m below Ordnance Datum Local

Recording zero = 6.368m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | NB42283264 | OSBM Bolt E side No 2 Wharf |
| Aux1 | NB42153271 | OSBM Bolt steps NE angle King Edward Wharf |
| Aux2 | NB42123275 | Amity Ho. E side Espl. Rd N face NW angle |
| Aux3 | NB42233280 | Bk. S side Worth Beach NW angle N face |

Data processing
.....

The tide gauge site is on the West side of No.2 Wharf and was upgraded to Dataring in April 1985 with sensors as follows:

Potentiometer linked to Ott pneumatic gauge in stilling well (Channel 1 back-up)

Digiquartz sensor on pressure gauge alongside (Channel 2 Class-A)

Missing scans were interpolated at the raw stage on the following days:

Jan 7,14, May 18, Jun 4,16,17, Jul 5 (2),6, Aug 9, Oct 26.

Multiple scans coinciding with T.G.I. visits on the 8 January and 16,17 November were edited.

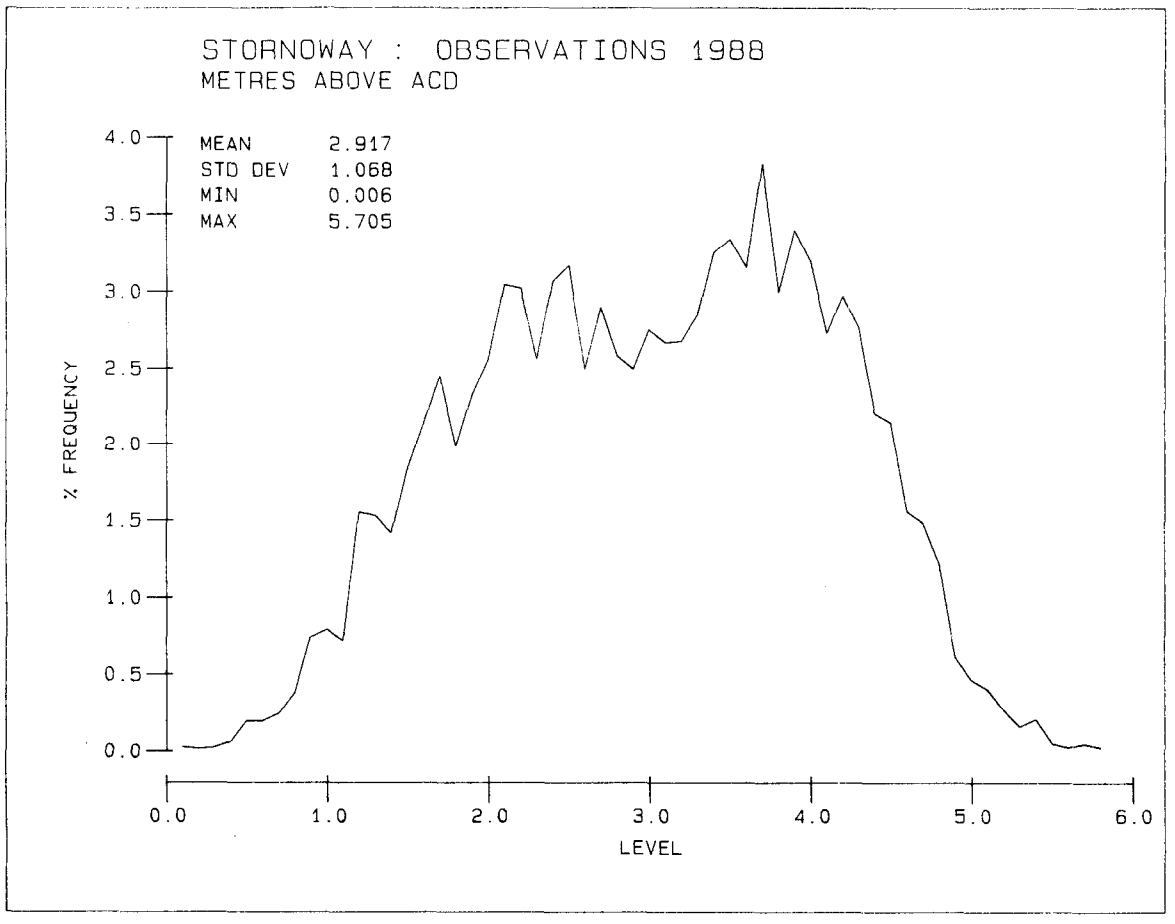
Gaps in 1988 filtered data from Channel 2
.....

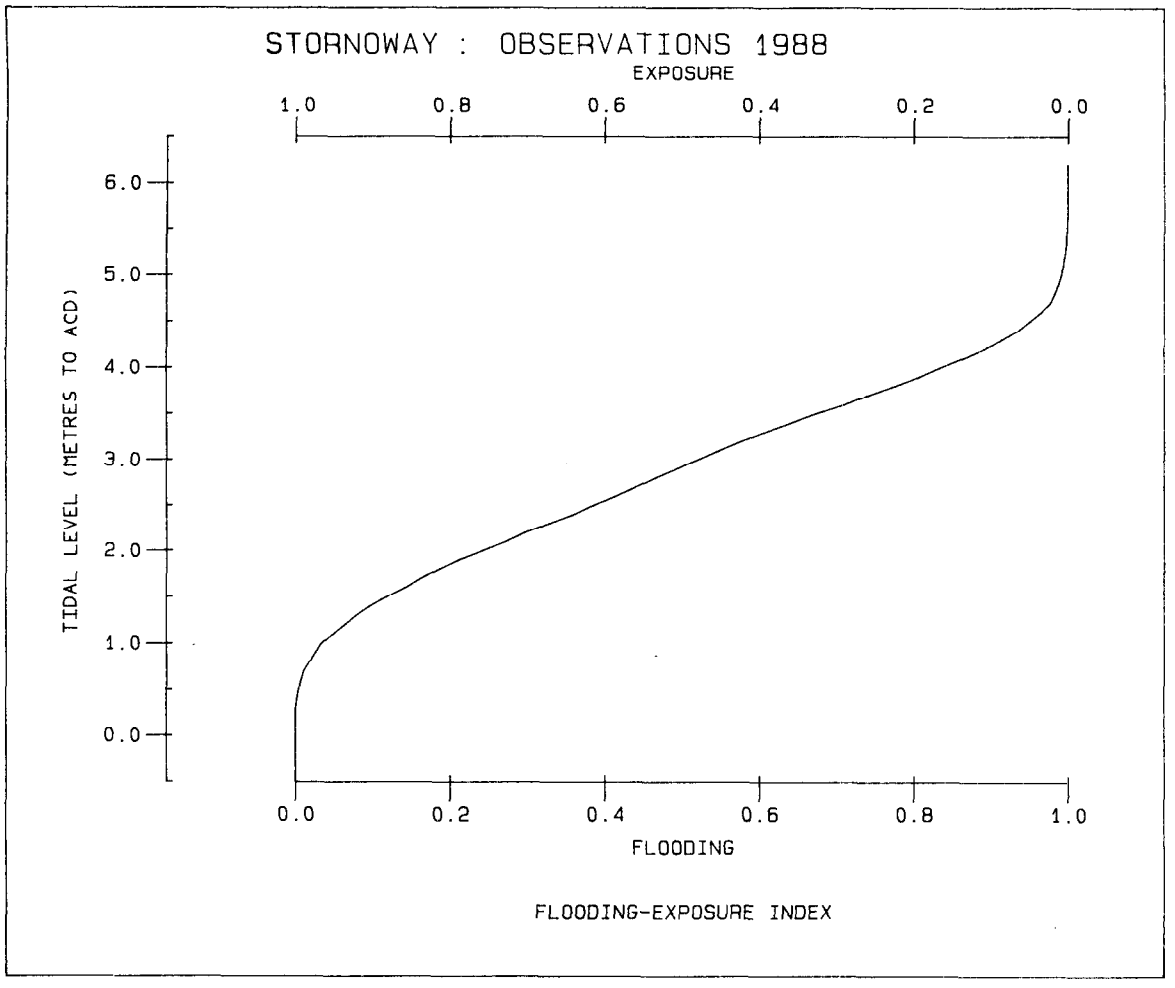
2300 GMT 19 July to 2200 GMT 20 July : Coinciding with TGI visit.

0800 GMT 22 August to 2000 GMT 15 September : Pressure tubing burned through.

Site diary
.....

| | |
|---|---|
| 8 January | TGI visit to check calibrations after errors in datum level reported.Tests showed a leak in one system. |
| 14 May | Channel 1 (back-up) failure. |
| 20 - 21 July | TGI visit. Channel 1 motor replaced. Both pressure points were loose,with Channel 2 tube found to have slipped down and parted from top connection. Pressure points removed,cleaned and reset to correct datum. |
| 6 August | Channel 1 pressure point slipped by 2 cm. |
| 22 August | Pressure tubing for Channel 2 burned through by hot slag from welding work on pier. |
| 16 September | New tubing and connections installed by diver. |
| 22 September | Channel 1 failed. |
| 16-17 November | TGI visit. Channel 1 repaired. |


STORNOWAY : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 2.917
STD DEV 1.068
MIN 0.006
MAX 5.705
% FREQUENCY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
LEVEL


STORNOWAY : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: SCOTLAND, WEST COAST - STORNOWAY

LATITUDE: 58 12' N

LONGITUDE: 6 23' W

TIME ZONE: GMT

LENGTH: 369 DAYS

FROM: 5TH DECEMBER, 1987 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 2.922

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 2.71 METRES BELOW ORDNANCE DATUM (LOCAL)

OBSERVATION MEAN = 0.2929D+01 RESIDUAL MEAN = 0.1306D-06
STD DEV = 0.1064D+01 STD DEV = 0.1539D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.037 | 300.72 |
| O1 | 0.092 | 348.69 |
| P1 | 0.038 | 122.99 |
| K1 | 0.130 | 136.23 |
| J1 | 0.007 | 223.04 |
| 2N2 | 0.035 | 149.03 |
| N2 | 0.283 | 176.27 |
| M2 | 1.383 | 197.59 |
| S2 | 0.547 | 230.95 |
| K2 | 0.155 | 228.84 |
| M3 | 0.027 | 116.22 |
| M4 | 0.061 | 220.46 |
| MS4 | 0.074 | 296.70 |
| M6 | 0.007 | 188.64 |

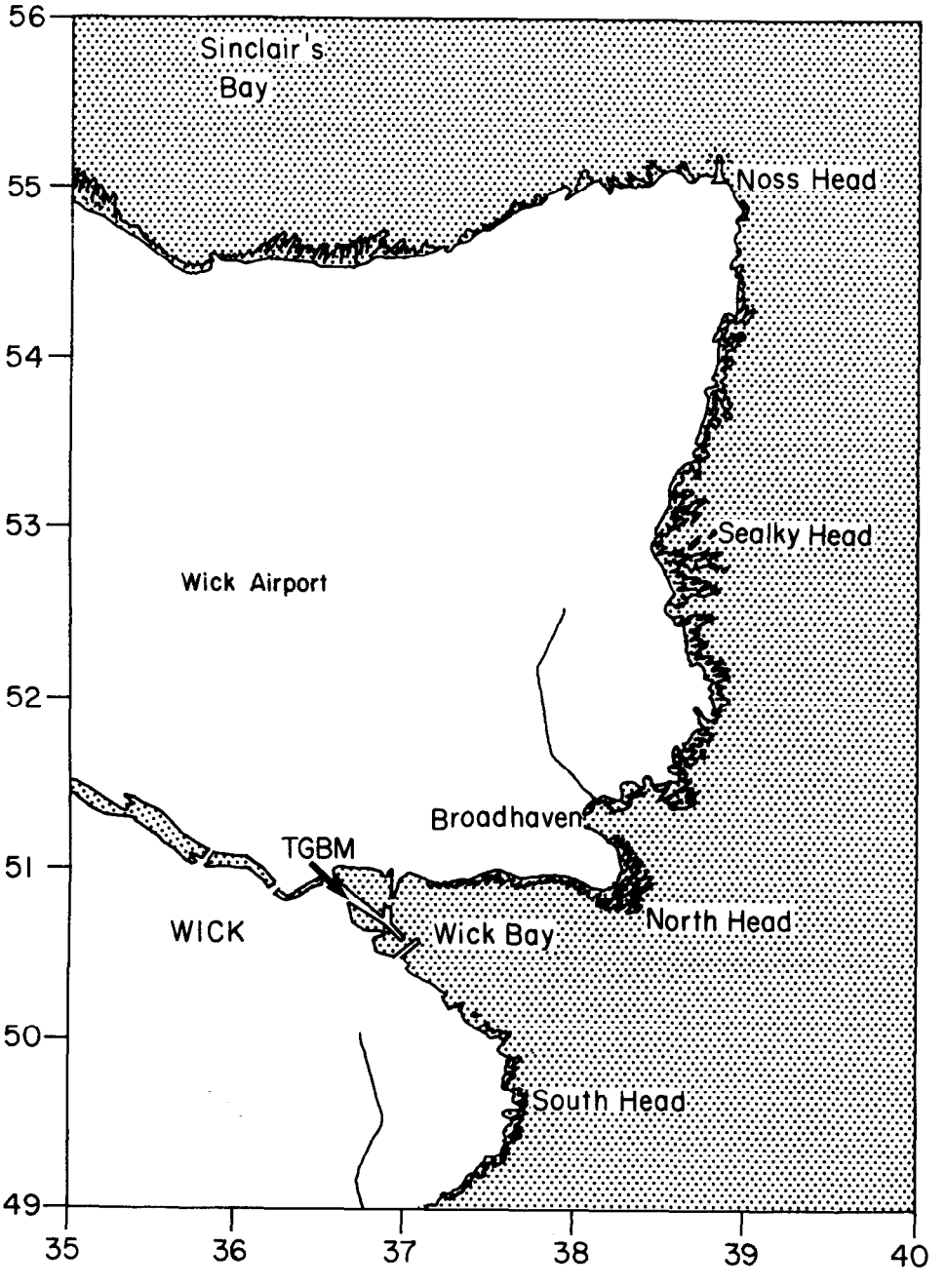
2.9 WICK

Latitude 58 deg 26' 28.8"N Longitude 03 deg 05' 5.7"W

National Grid reference ND 3667 5080

Recording zero = Chart Datum = 1.71m below Ordnance Datum Newlyn

Recording zero = 5.077m below Tide Gauge Bench Mark




| Bench Marks | NG Co-ords | Description |
|---|---|---|
| TGBM | ND36675081 | OSBM Bolt quay E angle tide gauge building. |
| Aux1 | ND36625083 | No.6 Harbour Quay E face SE angle. |
| Aux2 | ND36705083 | NBM Rivet base SE end wall NE side North Pier. |
| Aux3 | ND37055055 | Wall base steps SE side pier. |

Data processing
.....

The gauge site was connected to the Dataring in October 1985.

Potentiometer attached to stilling-well float (Channel 1 back-up)

Digiquartz on pressure gauge system (Channel 2 Class-A)

Filtering of the data from the back-up channel ceased in June 1987.

During the year, prior to editing to hourly levels isolated missing scans were interpolated on the following days: Jan 9 (2),14,28, Feb 13,21,29, Mar 29,31, Apr 2,28, May 14 (2),24, Jun 14,18, Jul 12,27, Aug 28, Sep 13, 14,23,27,28, Dec 1,29.

Extra scans coinciding with visits by Tide Gauge Inspectorate were edited on the 25 March and 19 October.

Gaps in 1988 filtered data from Channel 2
.....

0800 GMT 16 March to 1700 GMT 25 March : On-site modem not functioning.

2300 GMT 19 July to 2000 GMT 25 July : Suspect telephone fault

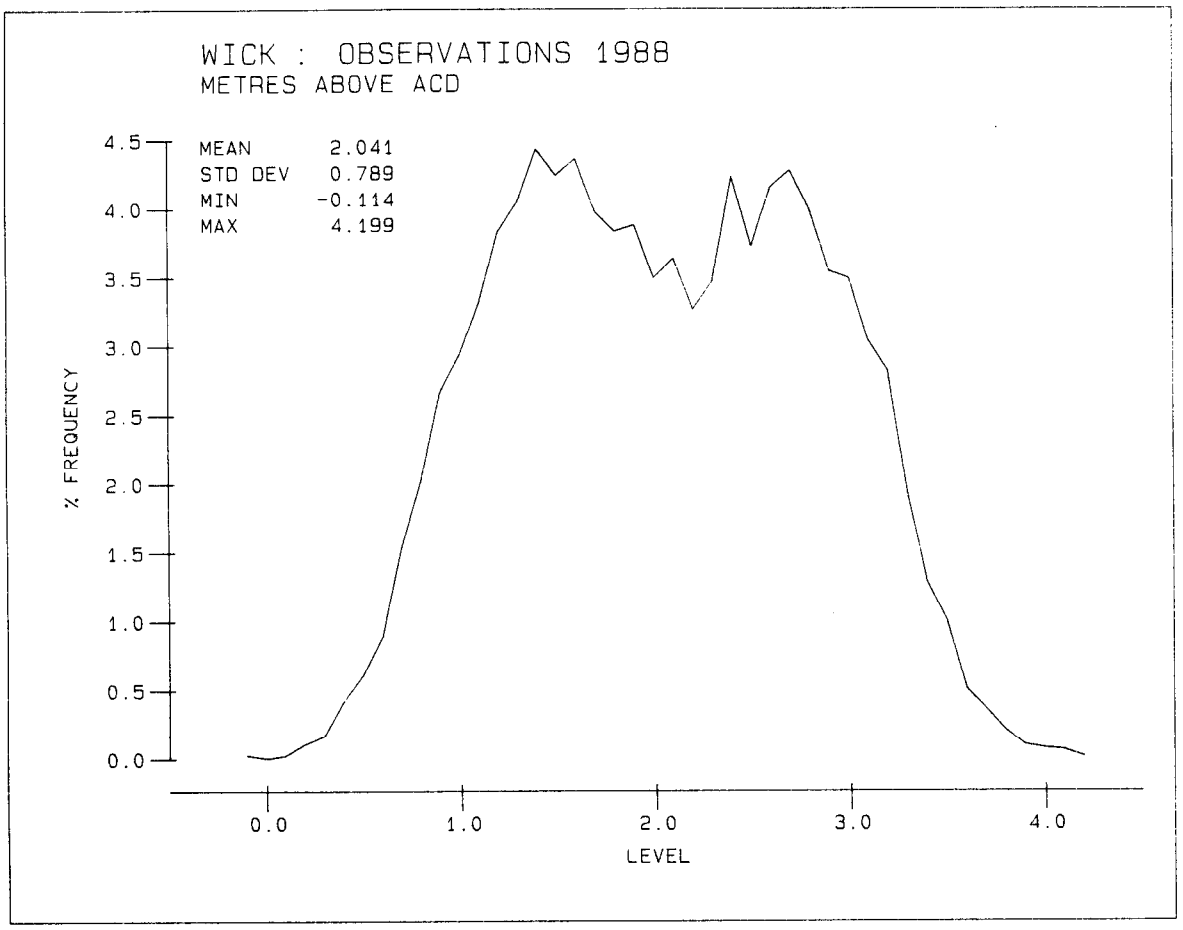
0300 GMT 18 August to 0300 GMT 20 August : Faulty modem-replaced.

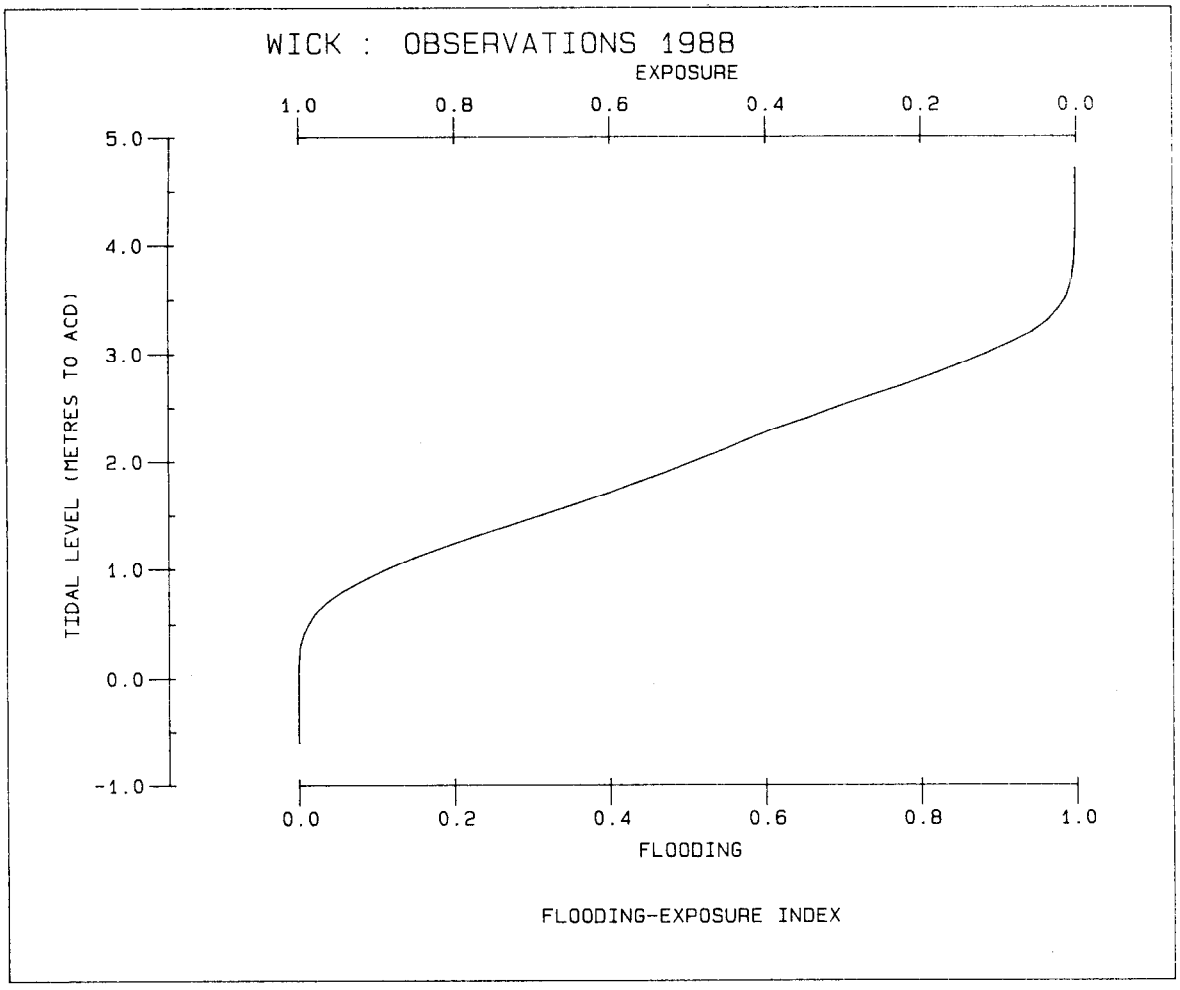
1100 GMT 04 October to 1300 GMT 06 October : Telephone line jammed- again.

0600 GMT 18 October to 2100 GMT 18 October : Coinciding with TGI visit

Site diary
.....

| | |
|---|---|
| 25 March | TGI visit. Faulty Modem replaced and routine maintenance carried out. |
| 25 July | Telephone connections replaced by British Telecom |
| 18-19 October | TGI visit. Modem replaced. |


WICK : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 2.041
STD DEV 0.789
MIN -0.114
MAX 4.199
% FREQUENCY
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
LEVEL


WICK : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: SCOTLAND, EAST COAST : WICK

LATITUDE: 58 26' 28.8" N

LONGITUDE: 3 05' 05.7" W

TIME ZONE: GMT

LENGTH: 382 DAYS

FROM: 1ST DECEMBER, 1987 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 2.040

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 1.71 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.2052D+01 RESIDUAL MEAN = 0.9622D-06
STD DEV = 0.7868D+00 STD DEV = 0.1473D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.044 | 340.96 |
| O1 | 0.114 | 26.64 |
| P1 | 0.033 | 161.43 |
| K1 | 0.110 | 177.31 |
| J1 | 0.007 | 263.89 |
| 2N2 | 0.026 | 297.16 |
| N2 | 0.208 | 301.54 |
| M2 | 1.014 | 321.88 |
| S2 | 0.350 | 359.36 |
| K2 | 0.099 | 357.35 |
| M3 | 0.011 | 223.59 |
| M4 | 0.037 | 314.18 |
| MS4 | 0.021 | 46.74 |
| M6 | 0.006 | 228.45 |

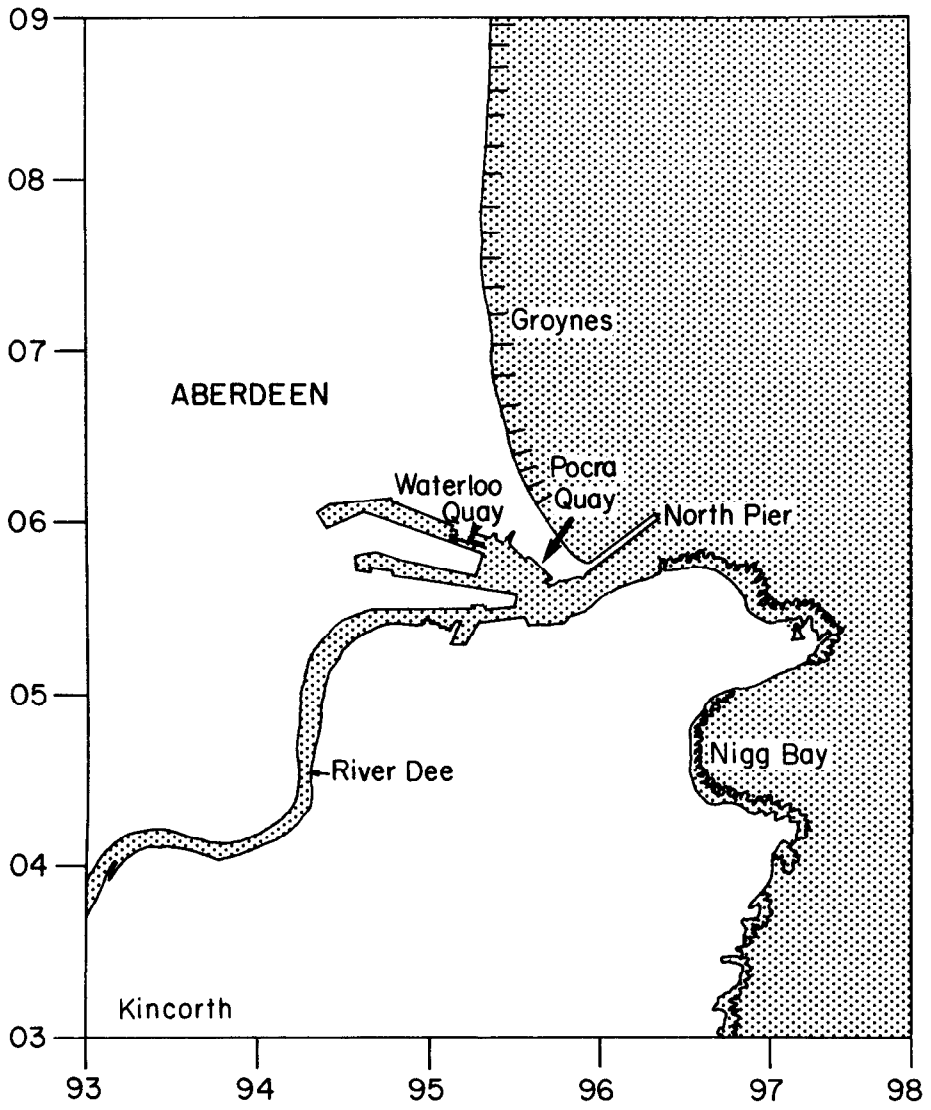
2.10 ABERDEEN

Latitude 57 deg 08' 36.0"N Longitude 02 deg 04' 23.0"W

National grid reference NJ 9524 0590 (Munro gauge on Waterloo Quay)

Recording zero = Chart Datum = 2.25m below Ordnance Datum Newlyn

Recording zero = 6.091m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | NJ95240590 | OSBM Bolt SE face tide gauge housing, Waterloo Quay. |
| Aux1 | NJ95720593 | Public Conv. E side Espl. W face SW angle. |
| Aux2 | NJ95860571 | Observatory Pocra Quay N face NW angle. |
| Aux3 | NJ95240600 | Bldg NE side Waterloo Quay SW face S angle. |

Data processing

Converted to the Dataring system in December 1985 with the following sensors:

Potentiometer attached to Munro gauge (Channel 1 back-up)

Digiquartz on pressure gauge system (Channel 2 Class-A)

Reduction of data from the back-up channel ceased in June 1987.

Values from the pressure gauge system are clearly affected by the fresh water flow during and after rainfall.Comparisons of the raw values with values from the stilling well show three distinct periods in 1988 when readings were low and coincided with wet weather:

25 January:5 cms low, then drifting back through February;16 March:3 cms low recovering over a few days and 20 October:3 cms low, recovering over 2 days.

Both the 25 January and 16 March events coincided with positive surges which, with the filtering process have the effect of masking the drift when hourly levels are studied (Section 3).

The stilling well figures also display problems in the form of a lag when compared with predicted values and/or values from the other data channel.

Before filtering to hourly levels,isolated missing scans were interpolated on the following dates: Jan 5, Feb 8,24, Mar 9, Apr 20, May 10, Jun 2,6,21, Jul 12, Aug 5,20,24, Sep 16,19, Nov 16 and Dec 30.

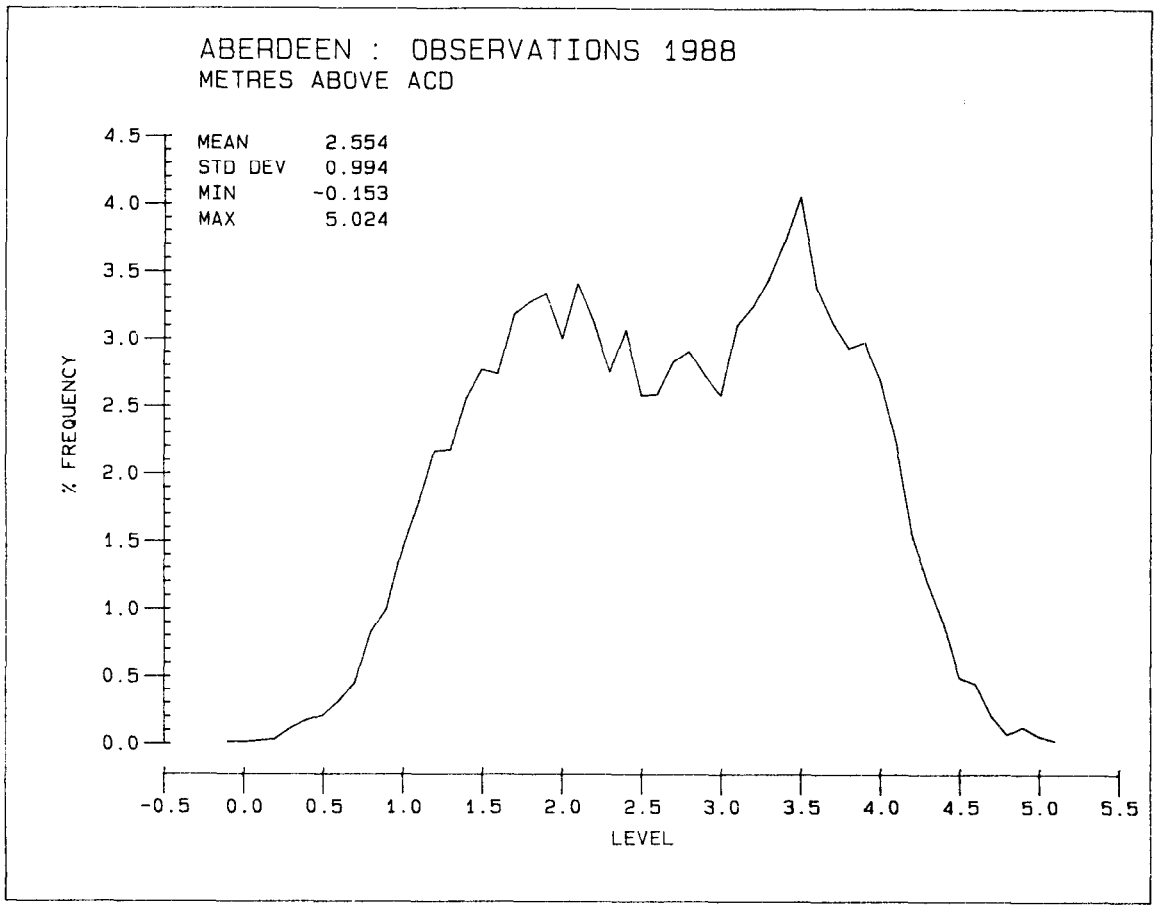
A gap of 3 hours on 17 October, which coincided with a visit by Tide Gauge Inspectorate was interpolated at the raw stage, as was a period of high frequency values recorded during their visit of 20 October.

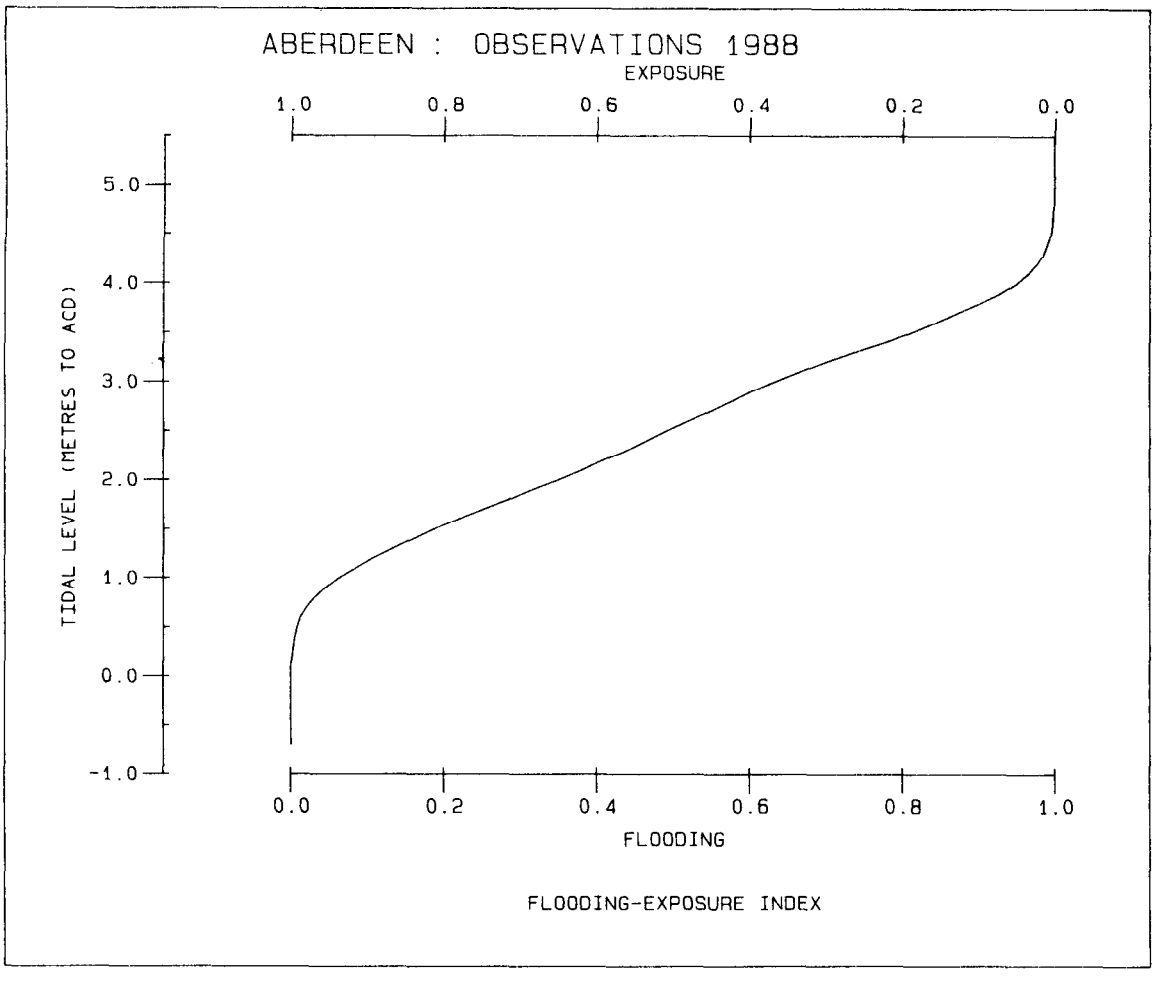
Gaps in filtered 1988 Channel 2 data

1200 GMT 14 December to 1100 GMT 16 December : Data deleted.Readings low due to compressor fault.

Site diary

| | |
|---|---|
| 18 July | TGI visit. Routine maintenance. |
| 17 October and 20 October | TGI visit. Calibration checks. |
| 16 December | Pneumatic channel reading 0.5m low.Compressor found to have been switched off.Normal operation restored by local operator. |


ABERDEEN : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 2.554
STD DEV 0.994
MIN -0.153
MAX 5.024
% FREQUENCY
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
LEVEL


ABERDEEN : OBSERVATIONS 1988
EXPOSURE
1.0 0.8 0.6 0.4 0.2 0.0
TIDAL LEVEL (METRES TO ACD)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0 0.2 0.4 0.6 0.8 1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: SCOTLAND, EAST COAST - ABERDEEN

LATITUDE: 57 08' 36.0" N

LONGITUDE: 2 04' 23.0" W

TIME ZONE: GMT

LENGTH: 363 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 2.556

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 2.25 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.2556D+01 RESIDUAL MEAN = 0.1010D-05
STD DEV = 0.9916D+00 STD DEV = 0.1334D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.050 | 5.67 |
| O1 | 0.128 | 49.43 |
| P1 | 0.034 | 187.61 |
| K1 | 0.116 | 205.23 |
| J1 | 0.010 | 292.93 |
| 2N2 | 0.026 | 351.36 |
| N2 | 0.264 | 1.36 |
| M2 | 1.299 | 24.36 |
| S2 | 0.444 | 62.30 |
| K2 | 0.127 | 60.86 |
| M3 | 0.010 | 315.50 |
| M4 | 0.035 | 161.28 |
| MS4 | 0.031 | 239.11 |
| M6 | 0.007 | 105.89 |

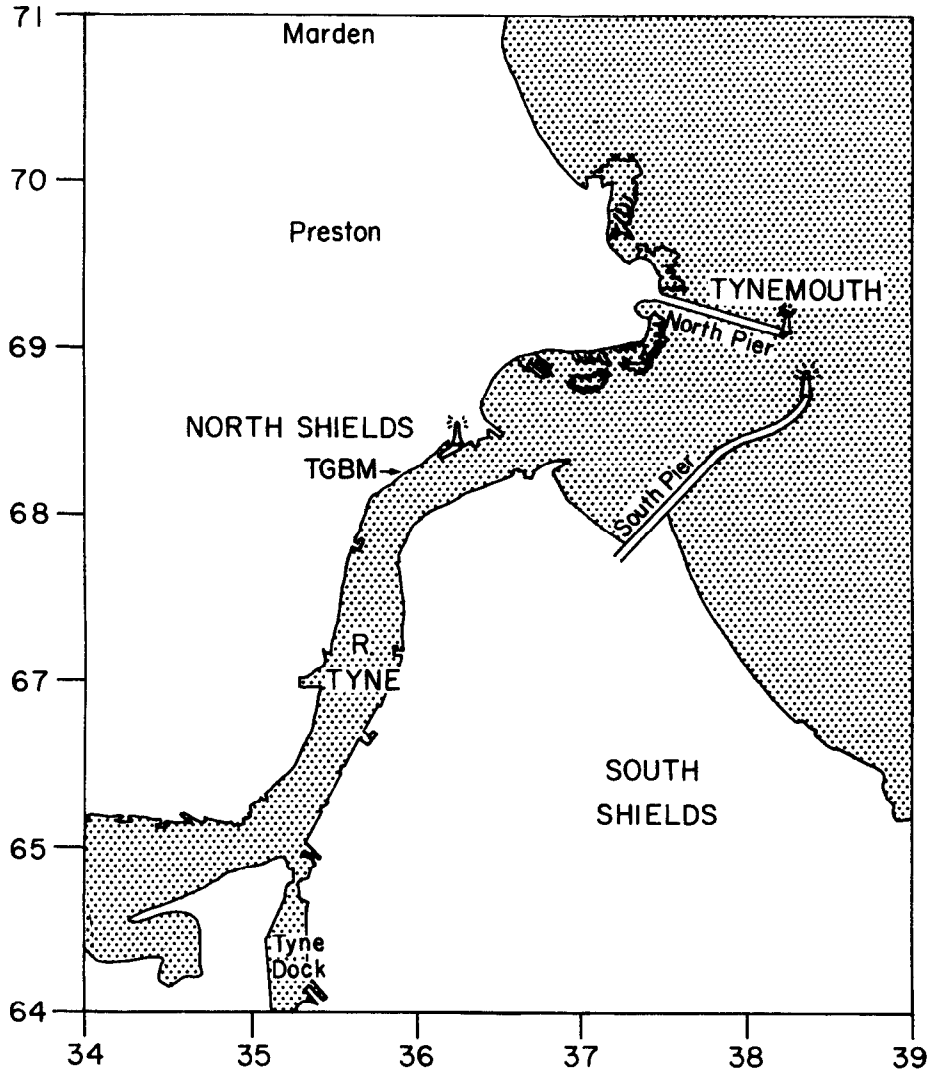
2.11 NORTH SHIELDS

Latitude 55 deg 00' 27.0"N Longitude 01 deg 26' 17.0"W

National Grid reference NZ 3592 6823

Recording zero = Chart Datum = 2.6m below Ordnance Datum Newlyn

Recording zero = 6.515m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | NZ35926823 | OSBM Bolt tide gauge building |
| Aux 1 | NZ36266842 | PA Bolt low lighthouse W face SW angle |
| Aux2 | NZ36306895 | PA Bolt butt N side railway |
| Aux3 | NZ35896823 | Building Western Quay E angle NE face |

Data processing
.....

Potentiometer on well-head unit of Ott gauge (Channel 1 back-up)

Potentiometer attached to Munro gauge (Channel 2 Class-A)

Both channels have been operational since June 1984.Since June 1986, Channel 1 has been treated as the back-up channel.

For the 1988 series, values have been fully processed from Channel 2 only.

Isolated missing values and spurious values have been interpolated prior to filtering to hourly levels: Jan 8, Feb 12, Jun 10, Aug 4.

1 December : Values interpolated over TGI visit period.

Gaps in 1988 filtered data from Channel 2
.....

1200 GMT 29 March to 1400 GMT 7 April : Microprocessor fault.

0900 GMT 18 December to 1800 GMT 19 December : Fault on telephone line.

Site diary
.....

07 April TGI visit. Microprocessor flags board replaced.

24 May TGI visit. Routine maintenance.

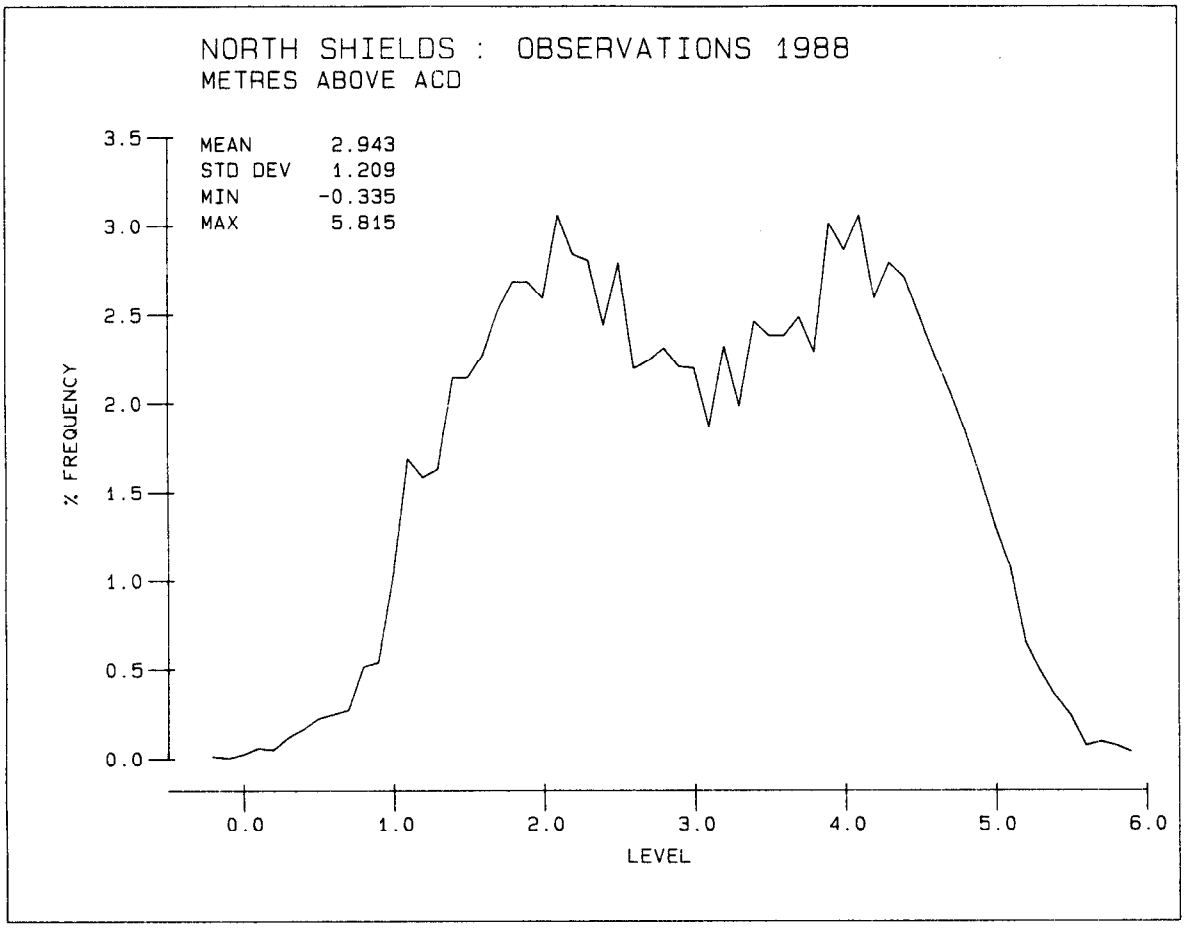
29 June TGI visit. Routine maintenance.

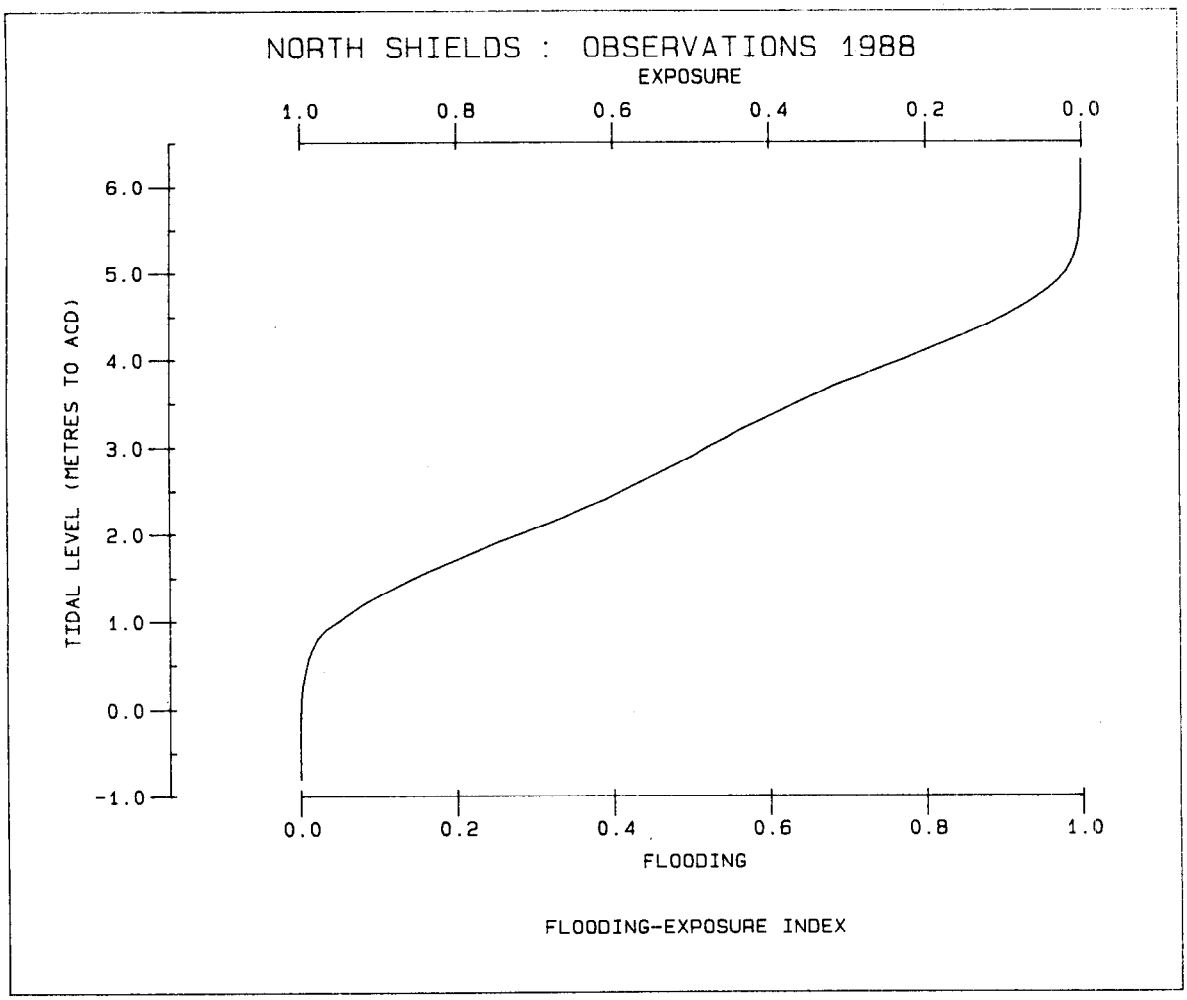
25 July Fault on Channel 1 (back-up) reported.

26 August TGI visit. Channel 1 system checked.

27 September TGI visit. Channel 1 potentiometer replaced.

01 December TGI visit. All integrated circuits replaced on Channel 1.
Channel 2 : Routine maintenance.


NORTH SHIELDS : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 2.943
STD DEV 1.209
MIN -0.335
MAX 5.815
% FREQUENCY
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
LEVEL


NORTH SHIELDS : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, EAST COAST - NORTH SHIELDS

LATITUDE: 55 00' 12.3" N

LONGITUDE: 1 26' 17.0" W

TIME ZONE: GMT

LENGTH: 356 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 2.942

HOURLY DATA FROM POTENTIOMETER GAUGE 2

DATUM OF OBSERVATIONS = ACD : 2.60 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.2945D+01 RESIDUAL MEAN = 0.3150D-07
STD DEV = 0.1209D+01 STD DEV = 0.1476D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.056 | 37.49 |
| O1 | 0.140 | 80.40 |
| P1 | 0.036 | 225.53 |
| K1 | 0.122 | 242.34 |
| J1 | 0.012 | 328.96 |
| 2N2 | 0.033 | 62.50 |
| N2 | 0.321 | 65.19 |
| M2 | 1.601 | 89.03 |
| S2 | 0.544 | 130.68 |
| K2 | 0.154 | 130.00 |
| M3 | 0.014 | 51.40 |
| M4 | 0.024 | 114.72 |
| MS4 | 0.017 | 90.16 |
| M6 | 0.007 | 5.44 |

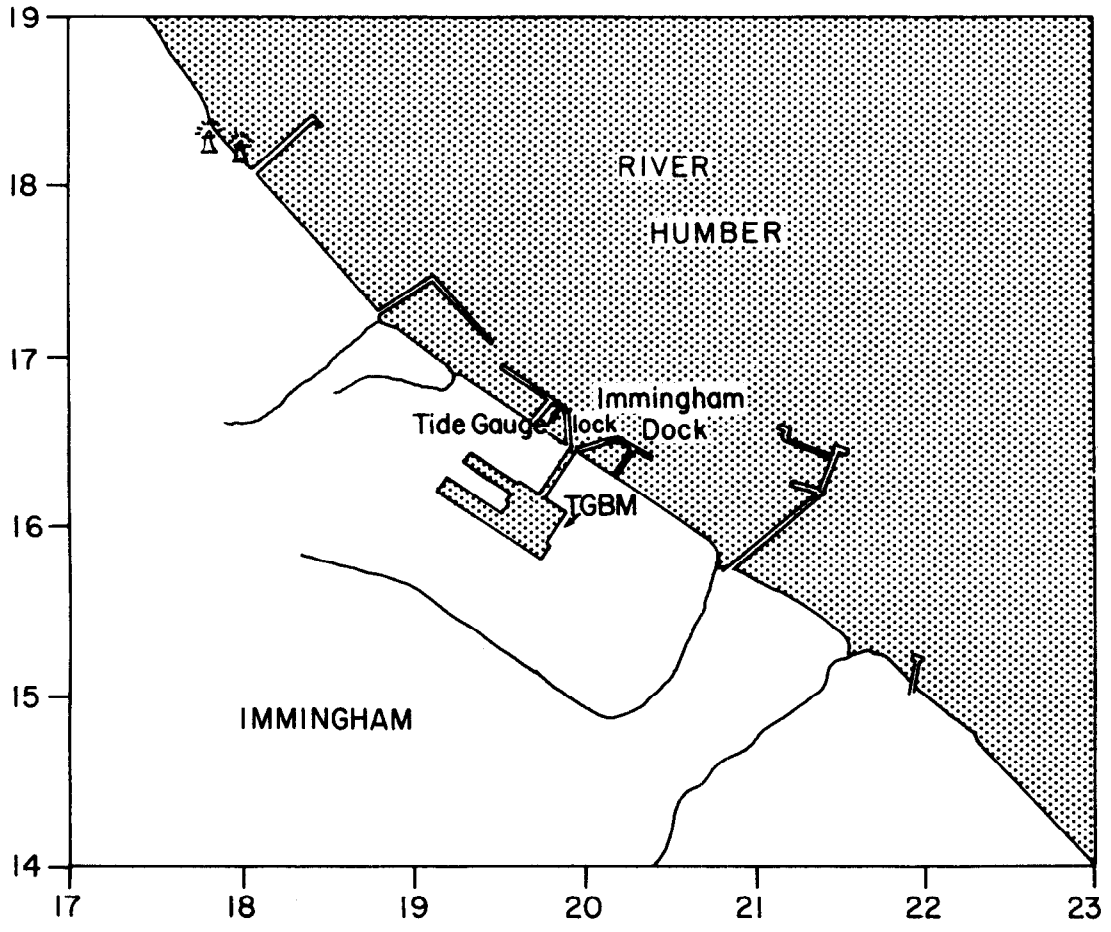
2.12 IMMINGHAM

Latitude 53 deg 37' 58.6"N  Longitude 00 deg 11' 13.0"W

National Grid Reference TA 1987 1672

Recording zero = Chart Datum = 3.9m below Ordnance Datum Newlyn

Recording zero = 9.131m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | TA19891630 | Fl Br G4658 Office bldg NE face N angle |
| AUX1 | TA20051631 | Bldg SW side road NE face E angle |
| AUX2 | TA20681535 | Fl Br G4483 Br SW para. SE angle NE face |
| AUX3 | TA19821676 | R conc pier 0·4m SW prod SE side jetty |

Data processing
.....

Potentiometer attached to Munro gauge float (Channel 1 back-up)

Digiquartz on pressure gauge system (Channel 2 Class-A)

Modernised to Dataring in June 1986, filtering of Channel 1 data ceased in March 1988.

Prior to filtering to hourly levels, missing scans were interpolated on the following dates in 1988 : Jan 19, Feb 18, Mar 20, May 24, Jun 7,28, Jul 13,27, Aug 4,9,19, Sep 8,21, Nov 2,18 and 19.

Extra scans caused during a visit by Tide Gauge Inspectorate were edited on the 24 August.

Gaps in 1988 filtered values from Channel 2
.....

Nil gaps.

Site diary
.....

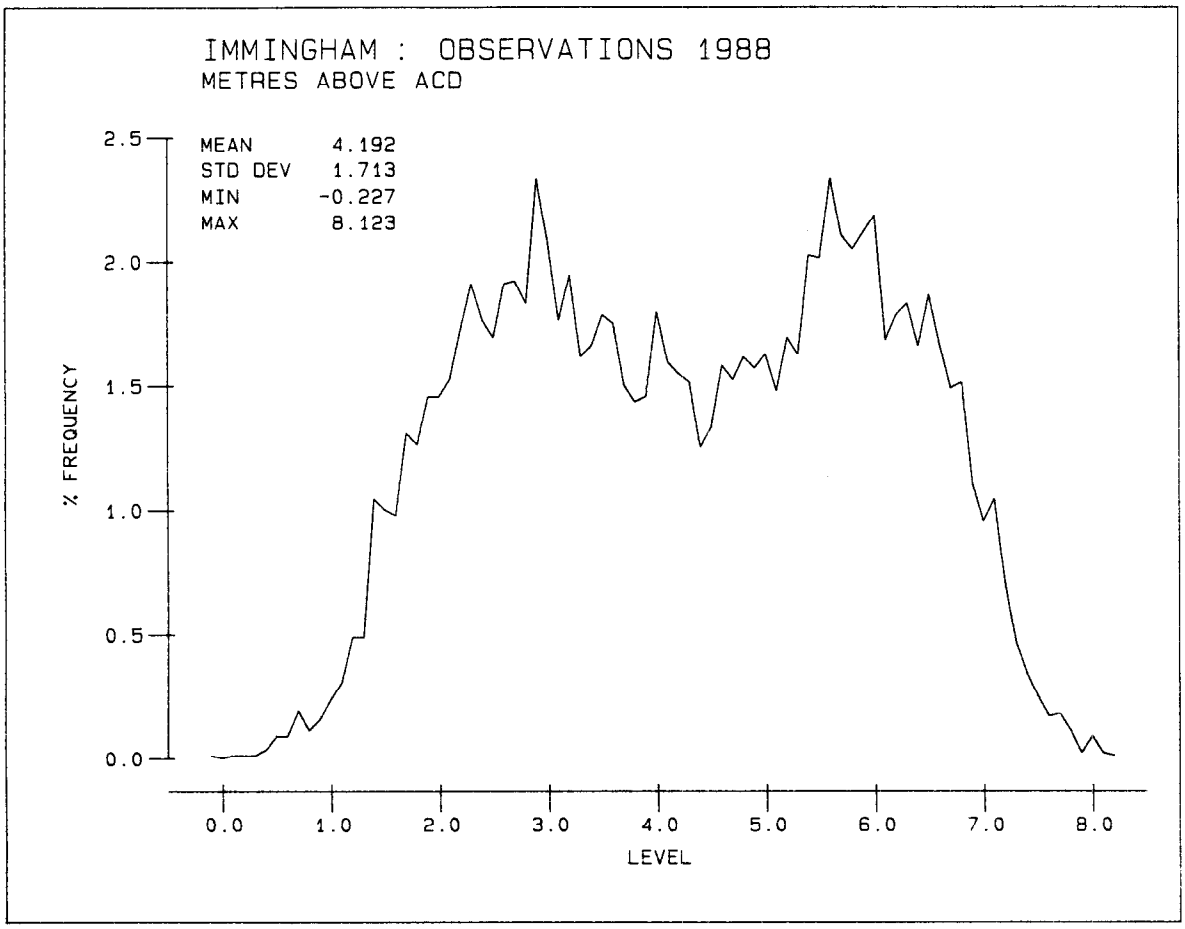
28 June TGI visit. Munro gauge and potentiometer checked. Parameters changed for water density and Latitude on microprocessor.

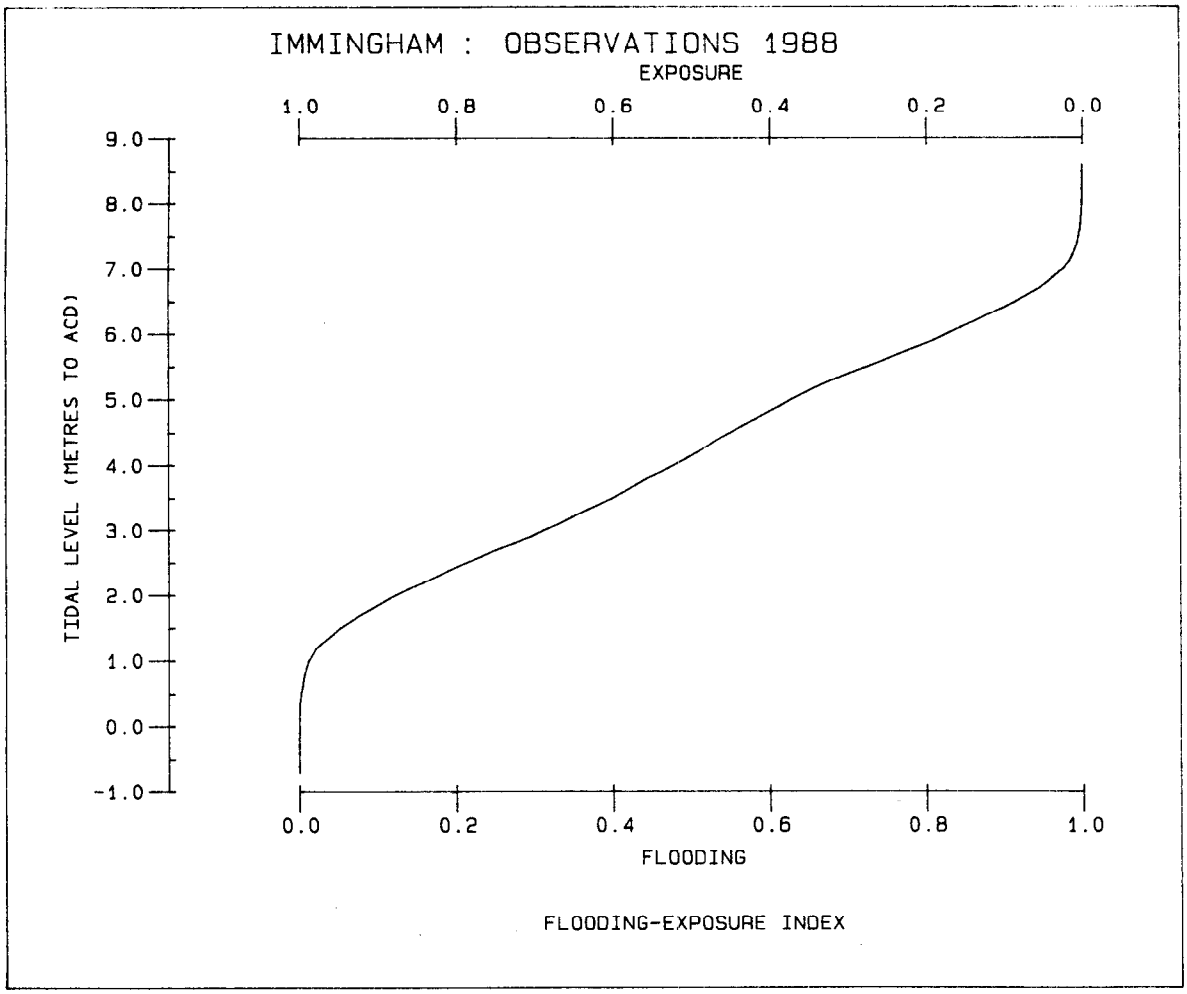
24 August TGI visit. Routine maintenance.

Two major points for concern at this site are:

a) Large density variations due to fresh water flow

b) Siltation of stilling well


IMMINGHAM : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 4.192
STD DEV 1.713
MIN -0.227
MAX 8.123
% FREQUENCY
2.5
2.0
1.5
1.0
0.5
0.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0
LEVEL


IMMINGHAM : OBSERVATIONS 1988
EXPOSURE
1.0 0.8 0.6 0.4 0.2 0.0
TIDAL LEVEL (METRES TO ACD)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0 0.2 0.4 0.6 0.8 1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, EAST COAST - IMMINGHAM

LATITUDE: 53 37' 58.6" N

LONGITUDE: 0 11' 13.0" W

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 4.192

HOURLY DATA FROM DIGIQUARTZ GAUGE

DATUM OF OBSERVATIONS = ACD : 3.90 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.4193D+01 RESIDUAL MEAN = 0.1808D-06
STD DEV = 0.1715D+01 STD DEV = 0.1872D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.071 | 70.22 |
| O1 | 0.172 | 112.36 |
| P1 | 0.048 | 267.10 |
| K1 | 0.157 | 280.74 |
| J1 | 0.016 | 6.89 |
| 2N2 | 0.055 | 123.27 |
| N2 | 0.434 | 139.69 |
| M2 | 2.279 | 161.37 |
| S2 | 0.761 | 211.43 |
| K2 | 0.219 | 210.03 |
| M3 | 0.022 | 189.92 |
| M4 | 0.018 | 178.51 |
| MS4 | 0.031 | 241.65 |
| M6 | 0.017 | 154.56 |

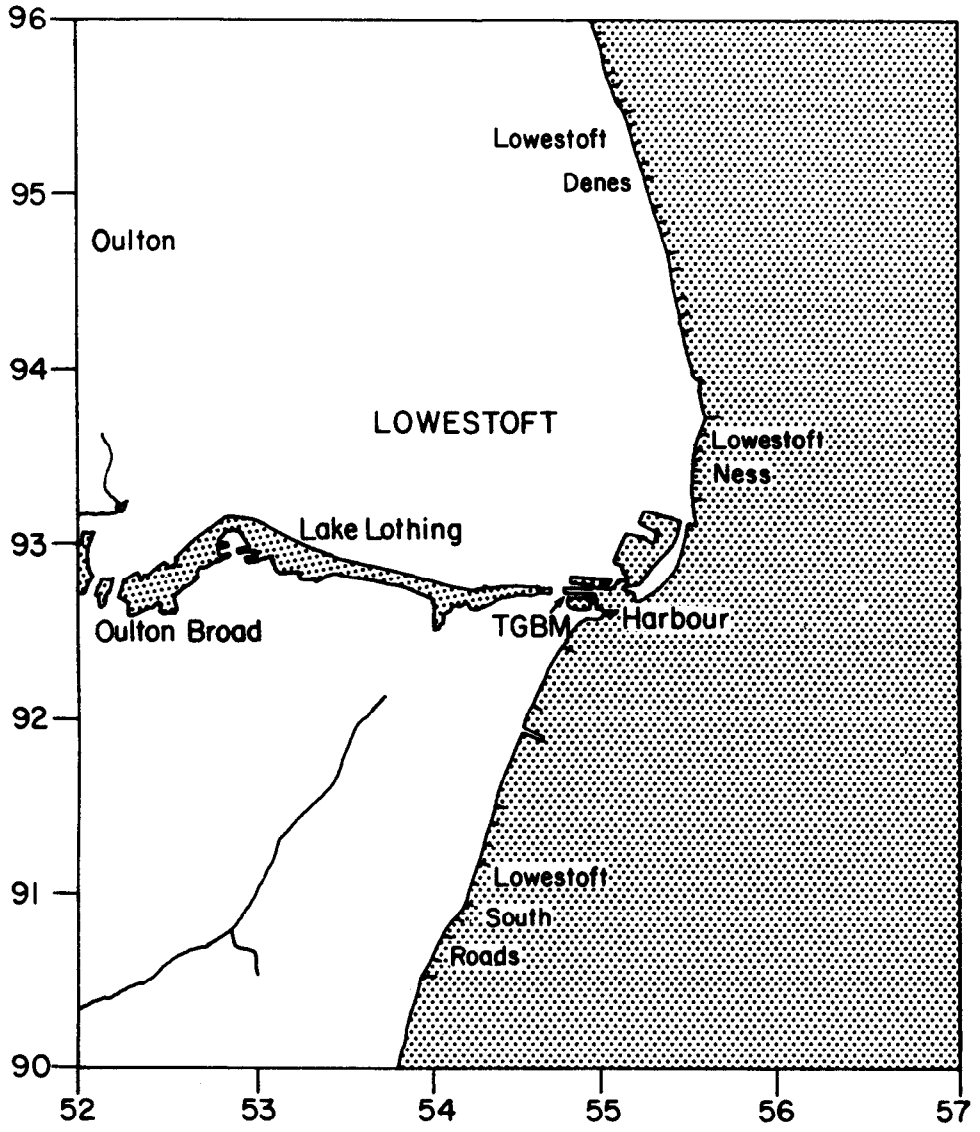
2.13 LOWESTOFT

Latitude 52 deg 28' 19.9"N  Longitude 01 deg 45' 6.3"E

National Grid reference TM 5477 9272

Recording zero = Chart Datum = 1.5m below Ordnance Datum Newlyn

Recording zero = 4.485m below Tide Gauge Bench Mark




| Bench Marks | NG Co-ords | Description |
|---|---|---|
| TGBM | TM54829273 | Bolt quay wall S side pier |
| Aux1 | TM54779272 | Bolt concrete jetty SW corner automatic TG recorder building. |
| Aux2 | TM54789272 | Harbourmasters Office SE angle S face |
| Aux3 | TM54729261 | Building SW side Royal Thoroughfare |

Data processing
.....

Upgraded with two potentiometer sensors in February and June 1985, respectively.

Channel 1 ,the back-up channel, is connected to a well-head unit on the Ott gauge well. Filtering of hourly heights from this channel ceased in October 1986.

Channel 2,the Class-A channel is connected to the Munro gauge.

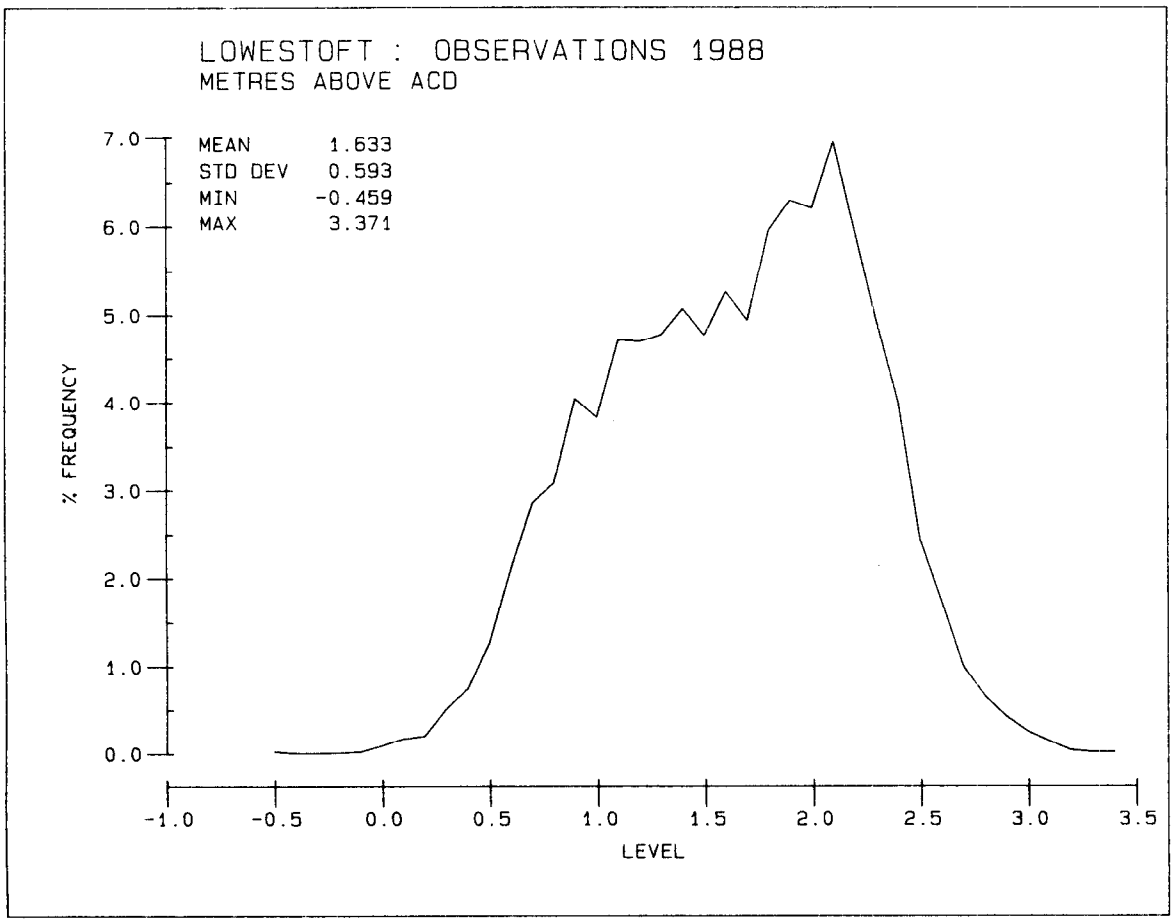
Missing values in the raw elevations were interpolated for the following dates : Jan 6,20,29, Feb 25, Mar 5,18, Apr 5,18, May 2, Jun 1,7,15, Jul 27, 29, Aug 9,13,16,23,27, Sep 8,9,Oct 18,19,23,Nov 9 (2),23.

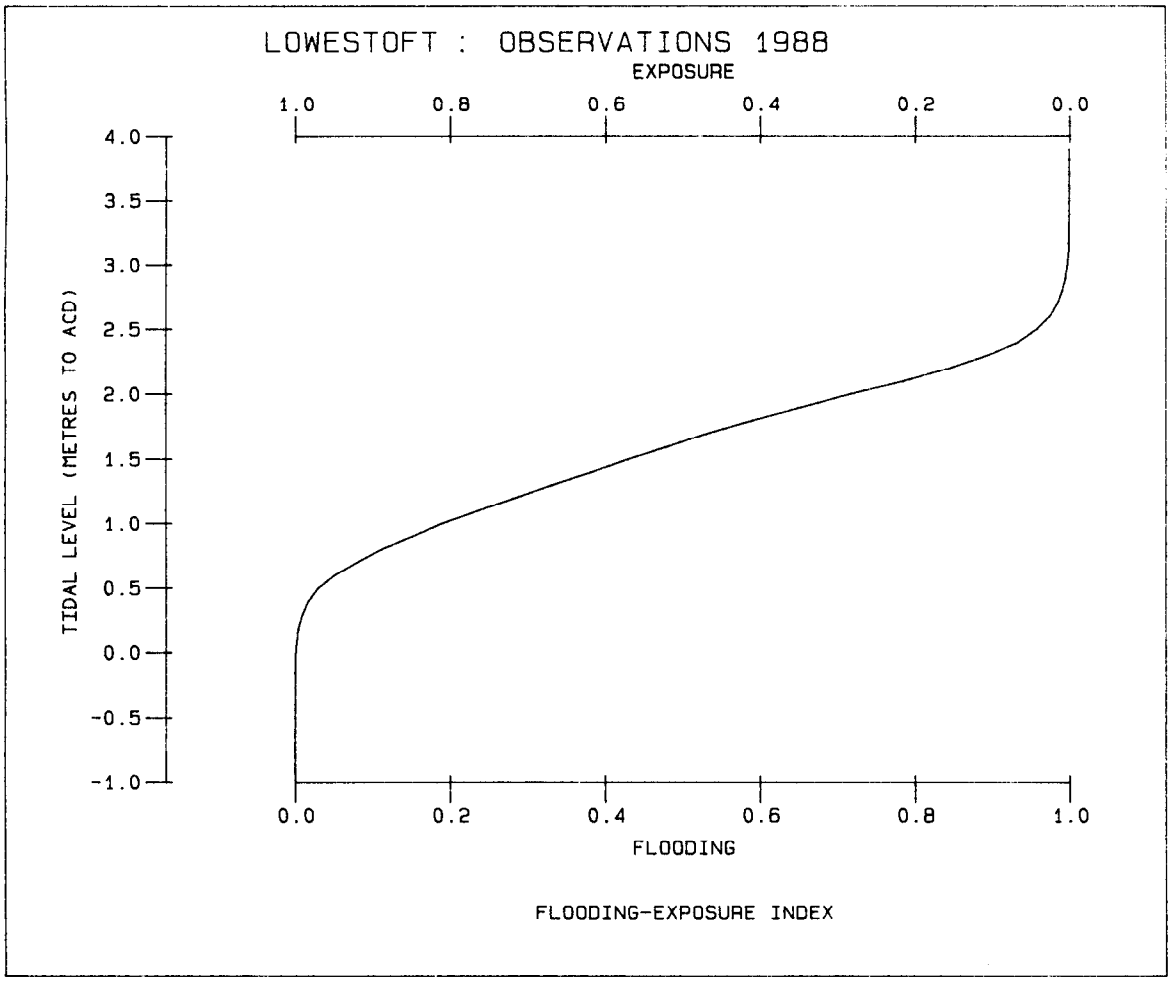
Gaps in 1988 filtered data from Channel 2
.....

Nil gaps.

Site diary
.....

| | |
|---|---|
| June | Repairs made to Ott gauge well.Bottom section secured. |
| 1 September | Installation hit by ship. |
| 15 September | TGI visit to inspect damage. |


LOWESTOFT : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 1.633
STD DEV 0.593
MIN -0.459
MAX 3.371
% FREQUENCY
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
LEVEL


LOWESTOFT : OBSERVATIONS 1988
EXPOSURE
1.0 0.8 0.6 0.4 0.2 0.0
TIDAL LEVEL (METRES TO ACD)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0.0 0.2 0.4 0.6 0.8 1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, EAST COAST - LOWESTOFT

LATITUDE: 52 28' 19.9" N

LONGITUDE: 1 45' 06.3" E

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 1.634

HOURLY DATA FROM POTENTIOMETER GAUGE 2

DATUM OF OBSERVATIONS = ACD : 1.50 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.1634D+01 RESIDUAL MEAN = 0.7607D-06
STD DEV = 0.5908D+00 STD DEV = 0.2159D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.059 | 113.27 |
| O1 | 0.137 | 157.40 |
| P1 | 0.043 | 317.83 |
| K1 | 0.122 | 330.10 |
| J1 | 0.013 | 67.32 |
| 2N2 | 0.005 | 261.76 |
| N2 | 0.143 | 231.45 |
| M2 | 0.703 | 259.54 |
| S2 | 0.217 | 297.92 |
| K2 | 0.061 | 299.61 |
| M3 | 0.007 | 281.77 |
| M4 | 0.050 | 332.12 |
| MS4 | 0.042 | 21.63 |
| M6 | 0.039 | 116.10 |

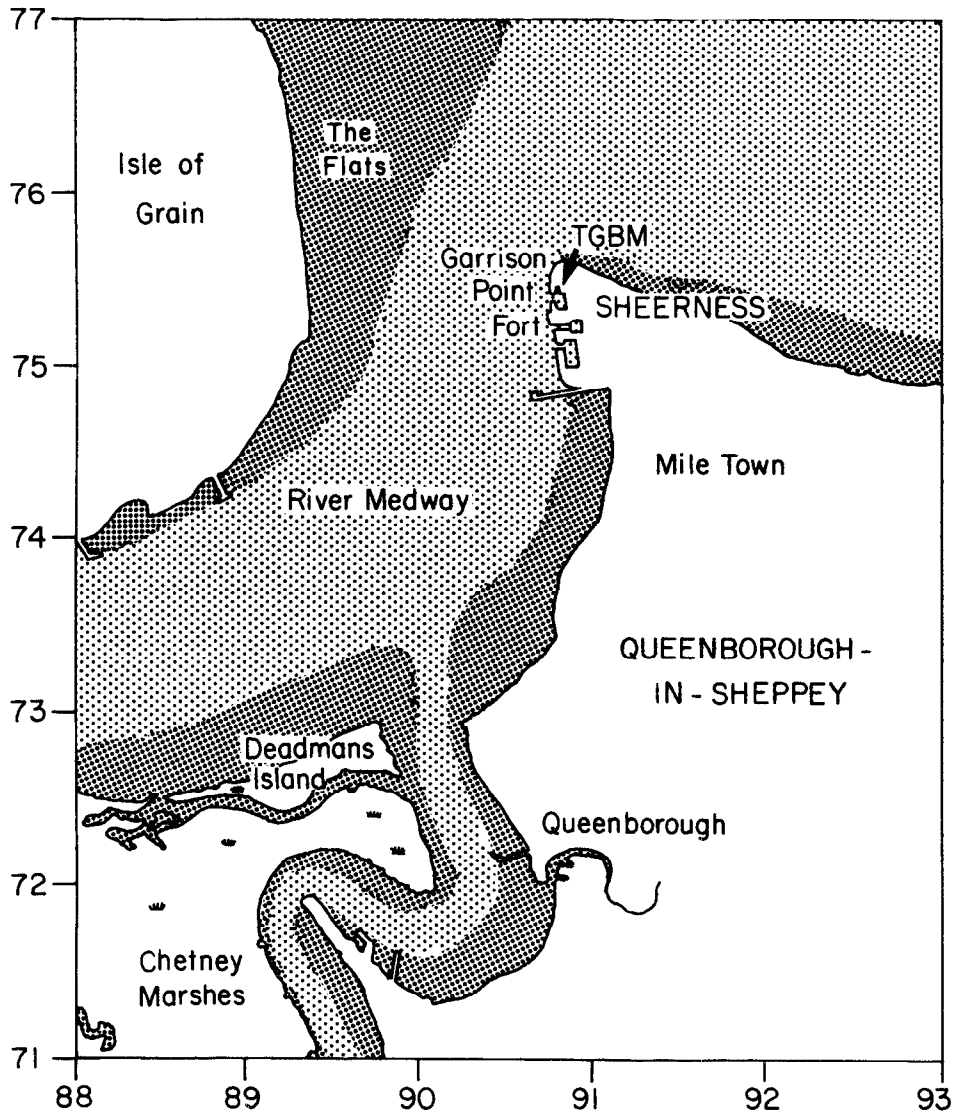
2.14 SHEERNESS

Latitude 51 deg 26' 44.0"N Longitude 00 deg 44' 42.5"E

National Grid reference TQ 9073 7542

Recording zero = Chart Datum = 2.9m below Ordnance Datum Newlyn

Recording zero = 7.532m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | TQ90807549 | Fl.Br. 11859 Garrison Pt Fort S angle 0·6m SW of building. |
| Aux1 | TQ91337523 | Fi.Br. G4790 Dockyard Cottages |
| Aux2 | TQ91157533 | Wall SW side road NE angle |
| Aux3 | TQ91477516 | PA Bolt disused church. |

Data processing
.....

The site was refurbished with two pressure gauge systems with quartz crystal sensors in October 1986.

Channel 2 has been designated as the Class-A channel with filtering of values from Channel 1 discontinued at the end of 1988.

Missing scans in the raw data for Channel 2 were interpolated for the dates : Jan 5,Feb 24,Apr 6,May 4,Jun 8,14,Jul 21,Aug 5,29,Sep 9,28,Nov 4, and Dec 1.

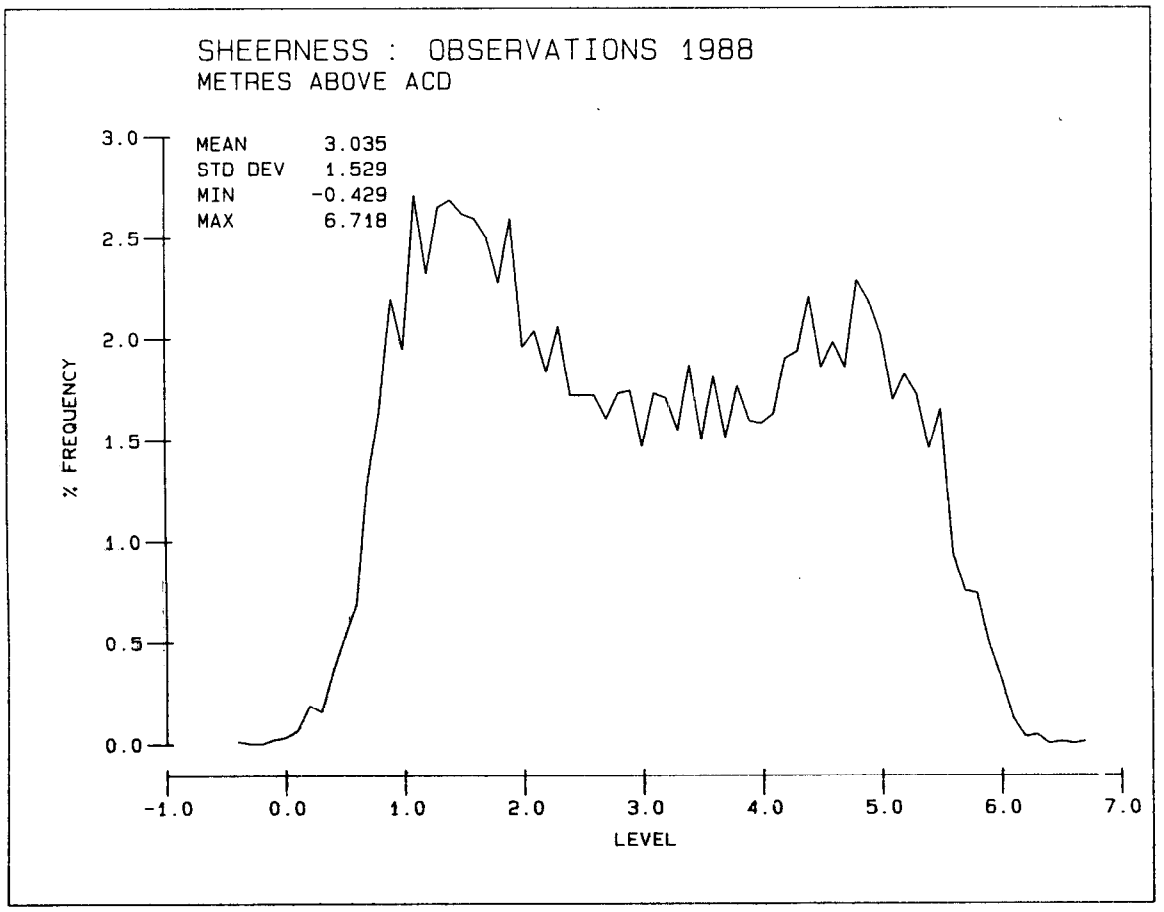
Gaps in 1988 processed data from Channel 2
.....

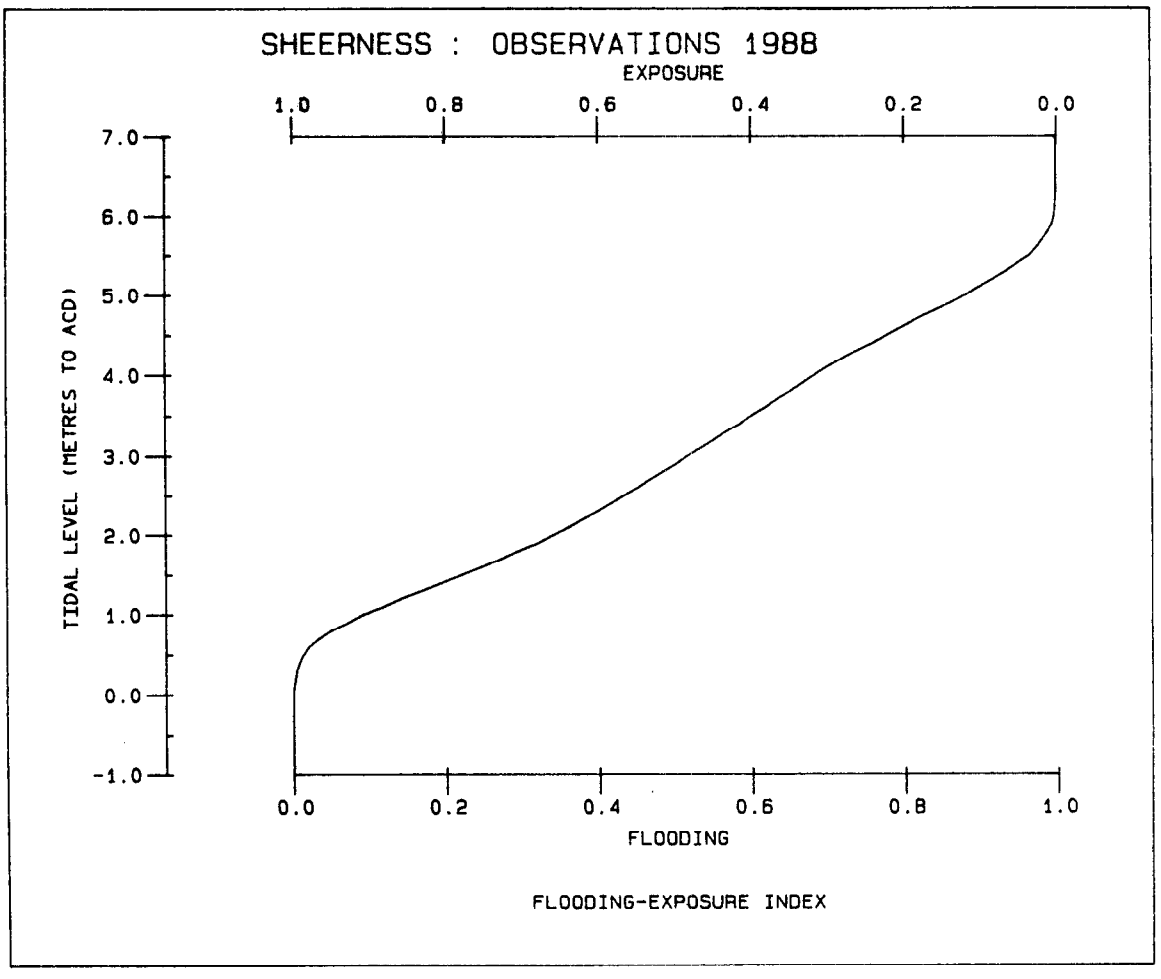
Nil gaps

Site diary
.....

The installation was washed away in the October 1987 severe storm and completely refurbished in the following November.

No further visits were necessary in 1988.


SHEERNESS : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 3.035
STD DEV 1.529
MIN -0.429
MAX 6.718
% FREQUENCY
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
LEVEL


SHEERNESS : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, EAST COAST - SHEERNESS

LATITUDE: 51 26' 44.0" N

LONGITUDE: 0 44' 42.5" E

TIME ZONE: GMT

LENGTH: 366 DAYS

FROM: 1ST JANUARY, 1988 TO: 31ST DECEMBER, 1988

UNITS: METRES A0: 3.036

HOURLY DATA FROM DIGIQUARTZ GAUGE 2

DATUM OF OBSERVATIONS = ACD : 2.90 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.3036D+01 RESIDUAL MEAN = 0.6943D-06
STD DEV = 0.1530D+01 STD DEV = 0.2304D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.057 | 139.76 |
| O1 | 0.129 | 186.83 |
| P1 | 0.042 | 349.76 |
| K1 | 0.114 | 10.61 |
| J1 | 0.014 | 108.08 |
| 2N2 | 0.060 | 12.74 |
| N2 | 0.356 | 327.79 |
| M2 | 2.046 | 353.27 |
| S2 | 0.597 | 49.62 |
| K2 | 0.174 | 49.28 |
| M3 | 0.018 | 87.03 |
| M4 | 0.129 | 7.00 |
| MS4 | 0.046 | 76.55 |
| M6 | 0.054 | 34.87 |

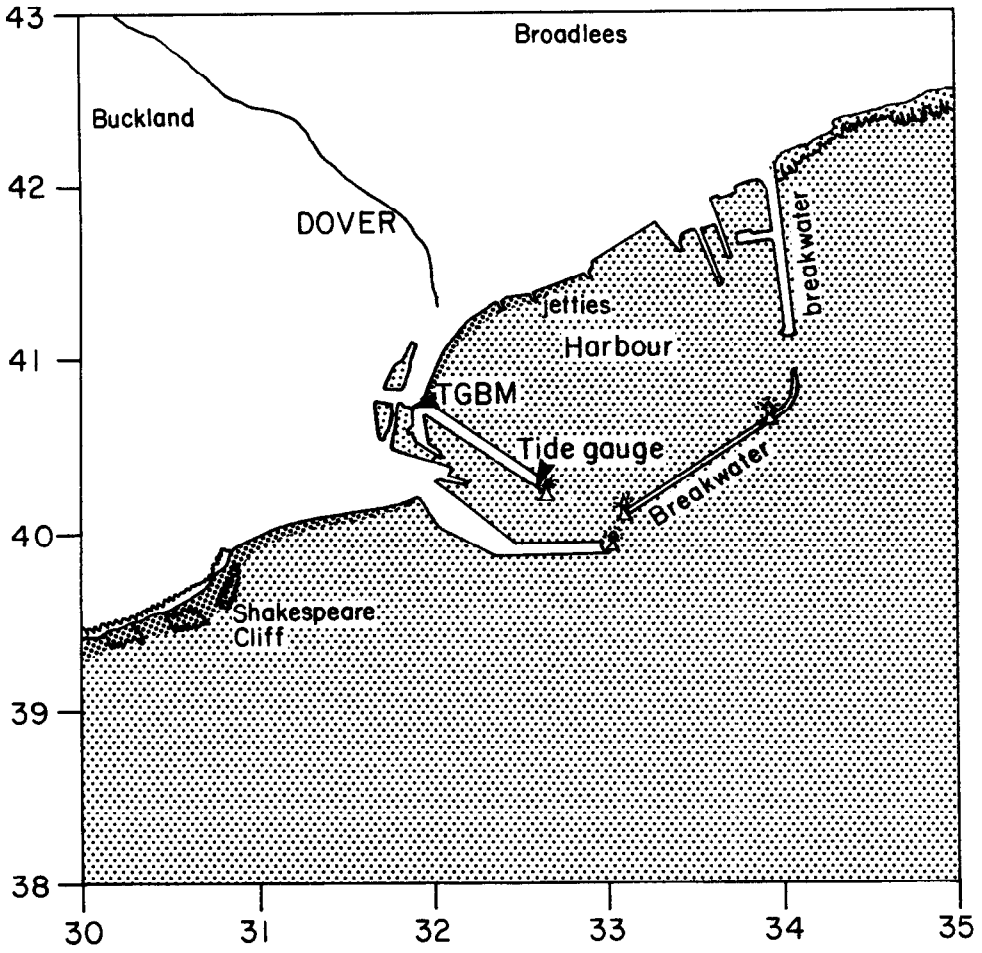
2.15 DOVER

Latitude 51 deg 07' 1.0"N  Longitude 01 deg 19' 5.4"E

National Grid Reference TR 3220 4055

Recording zero = Chart Datum = 3.67m below Ordnance Datum Newlyn

Recording zero = 10.491m below Tide Gauge Bench Mark




| Bench Marks | NG co-ords | Description |
|---|---|---|
| TGBM | TR31934074 | Fl. Br. G4868 bldg E side ent. works. |
| Aux1 | TR31954095 | No.29 Waterloo Cres. SW face S angle |
| Aux2 | TR32284053 | Rivet pier wall NE side pier facing junc. |
| Aux3 | TR32654026 | Rivet steps NE side p. of W pier 1·0m SE W angle. |

Data processing
.....

Two stilling wells sited on Prince of Wales pier are furnished with potentiometer sensors.Channel 1 ,with the potentiometer connected to a well-head unit in the Ott gauge well is treated as the back-up channel of data.

Regular filtering of this channel's data ceased in December 1987.

Channel 2's sensor,the Class-A channel, is connected to The Munro gauge.

Before filtering values to hourly heights for Channel 2 missing values were interpolated on the following dates : Feb 8,Mar 2,Apr 6,May 4,6,20, Jun 2,29,Jul 21,Aug 1,3,4,7,16,24, Sep 8,16 and 30.

Gaps in 1988 filtered data from Channel 2
.....

0600 GMT 6 October to 0300 GMT 7 October : Memory loss at site.

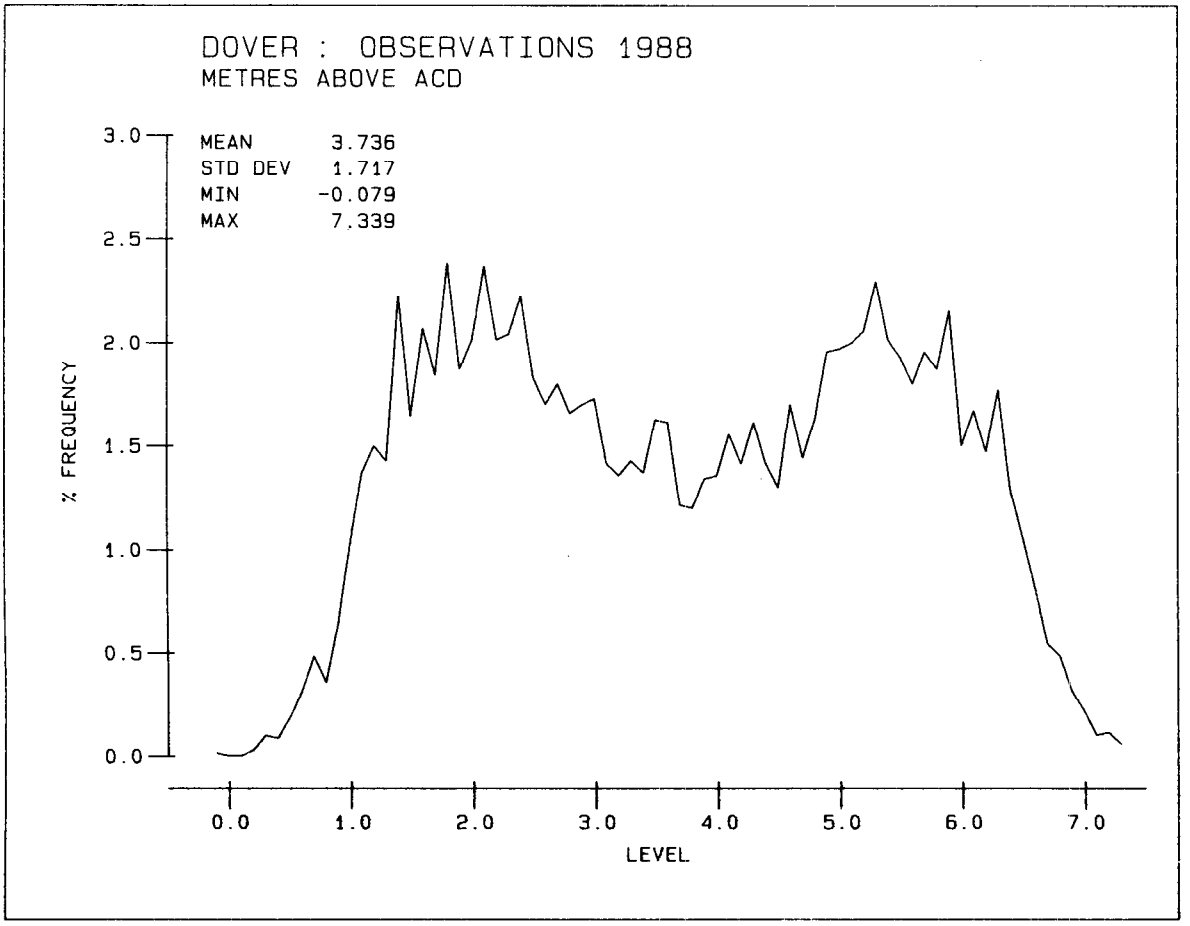
1900 GMT 19 October to end of year : Counterweight lost down well.

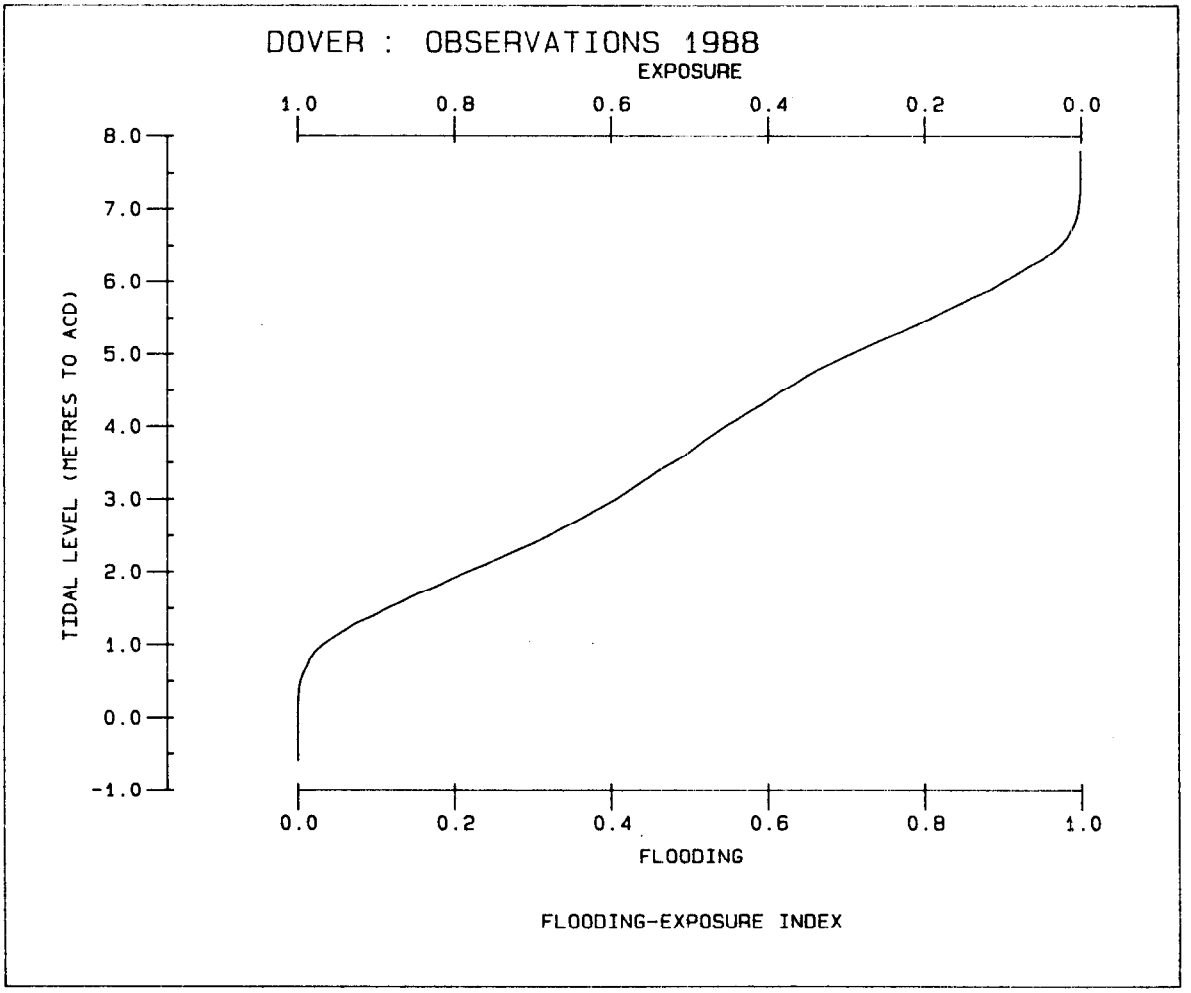
Site diary
.....

25 August Channel 1 well (back-up) bottom section washed away.

19 October Visit by Ordnance Survey.

November Equipment damaged by divers on site to repair back-up well.


DOVER : OBSERVATIONS 1988
METRES ABOVE ACD
MEAN 3.736
STD DEV 1.717
MIN -0.079
MAX 7.339
% FREQUENCY
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
LEVEL


DOVER : OBSERVATIONS 1988
EXPOSURE
1.0
0.8
0.6
0.4
0.2
0.0
TIDAL LEVEL (METRES TO ACD)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
0.2
0.4
0.6
0.8
1.0
FLOODING
FLOODING-EXPOSURE INDEX

PROUDMAN OCEANOGRAPHIC LABORATORY (BIDSTON OBSERVATORY)

HARMONIC TIDAL ANALYSIS.

PORT: ENGLAND, SOUTH COAST - DOVER

LATITUDE: 51 07' 01.0" N

LONGITUDE: 1 19' 05.4" E

TIME ZONE: GMT

LENGTH: 364 DAYS

FROM: 19TH OCTOBER, 1987 TO: 18TH OCTOBER, 1988

UNITS: METRES A0: 3.749

HOURLY DATA FROM POTENTIOMETER GAUGE 2

DATUM OF OBSERVATIONS = ACD : 3.67 METRES BELOW ORDNANCE DATUM (NEWLYN)

OBSERVATION MEAN = 0.3748D+01 RESIDUAL MEAN = 0.3225D-06
STD DEV = 0.1715D+01 STD DEV = 0.1679D+00

| CONSTITUENT | H | G |
|---|---|---|
| Q1 | 0.029 | 123.16 |
| O1 | 0.054 | 175.39 |
| P1 | 0.018 | 23.03 |
| K1 | 0.052 | 41.87 |
| J1 | 0.006 | 152.49 |
| 2N2 | 0.049 | 291.04 |
| N2 | 0.420 | 308.72 |
| M2 | 2.283 | 331.44 |
| S2 | 0.728 | 23.04 |
| K2 | 0.208 | 22.27 |
| M3 | 0.010 | 46.50 |
| M4 | 0.270 | 219.23 |
| MS4 | 0.176 | 272.14 |
| M6 | 0.069 | 103.45 |

# 3. ANALYSED DATA STATISTICS

## 3.1 EXTREME LEVEL VALUES

In this part of Section Three, the extreme levels obtained from the hourly levels for 1988 for each month are presented, relative to the datum of the data, which for each site equates with the local Chart Datum. The values are also given relative to Ordnance Datum Newlyn.

As in the previous section the sites are in geographical order, clockwise from Newlyn.

NEWLYN

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.418 | 21 | 13 | 5.771 | 23 | 8 |
| FEBRUARY | 0.212 | 19 | 13 | 5.847 | 19 | 6 |
| MARCH | 0.442 | 19 | 0 | 6.070 | 19 | 5 |
| APRIL | 0.654 | 16 | 11 | 5.943 | 16 | 4 |
| MAY | 0.821 | 15 | 23 | 5.677 | 2 | 17 |
| JUNE | 1.029 | 3 | 1 | 5.640 | 30 | 17 |
| JULY | 0.558 | 31 | 0 | 5.764 | 2 | 19 |
| AUGUST | 0.328 | 30 | 1 | 6.056 | 28 | 17 |
| SEPTEMBER | 0.380 | 27 | 0 | 6.060 | 26 | 17 |
| OCTOBER | 0.744 | 25 | 11 | 6.045 | 25 | 16 |
| NOVEMBER | 0.749 | 23 | 23 | 5.532 | 10 | 5 |
| DECEMBER | 0.875 | 12 | 13 | 5.415 | 23 | 4 |
| ANNUAL | 0.212 | 19 | 13 | 6.070 | 19 | 5 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.632 | 21 | 13 | 2.721 | 23 | 8 |
| FEBRUARY | -2.838 | 19 | 13 | 2.797 | 19 | 6 |
| MARCH | -2.608 | 19 | 0 | 3.020 | 19 | 5 |
| APRIL | -2.396 | 16 | 11 | 2.893 | 16 | 4 |
| MAY | -2.229 | 15 | 23 | 2.627 | 2 | 17 |
| JUNE | -2.021 | 3 | 1 | 2.590 | 30 | 17 |
| JULY | -2.492 | 31 | 0 | 2.714 | 2 | 19 |
| AUGUST | -2.722 | 30 | 1 | 3.006 | 28 | 17 |
| SEPTEMBER | -2.670 | 27 | 0 | 3.010 | 26 | 17 |
| OCTOBER | -2.306 | 25 | 11 | 2.995 | 25 | 16 |
| NOVEMBER | -2.301 | 23 | 23 | 2.482 | 10 | 5 |
| DECEMBER | -2.175 | 12 | 13 | 2.365 | 23 | 4 |
| ANNUAL | -2.838 | 19 | 13 | 3.020 | 19 | 5 |

# ILFRACOMBE

## DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.495 | 21 | 14 | 9.663 | 23 | 9 |
| FEBRUARY | -0.068 | 19 | 13 | 9.912 | 19 | 7 |
| MARCH | 0.212 | 18 | 12 | 10.200 | 19 | 7 |
| APRIL | 0.604 | 17 | 12 | 9.818 | 17 | 6 |
| MAY | 0.945 | 15 | 11 | 9.190 | 2 | 18 |
| JUNE | 1.376 | 3 | 1 | 9.104 | 30 | 18 |
| JULY | 0.566 | 31 | 1 | 9.651 | 31 | 20 |
| AUGUST | 0.263 | 30 | 2 | 10.140 | 28 | 19 |
| SEPTEMBER | 0.239 | 27 | 0 | 10.270 | 27 | 19 |
| OCTOBER | 0.685 | 24 | 23 | 10.100 | 25 | 18 |
| NOVEMBER | 0.931 | 23 | 11 | 9.145 | 10 | 6 |
| DECEMBER | 1.241 | 10 | 12 | 9.042 | 23 | 6 |
| ANNUAL | -0.068 | 19 | 13 | 10.270 | 27 | 19 |

## DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -4.305 | 21 | 14 | 4.863 | 23 | 9 |
| FEBRUARY | -4.868 | 19 | 13 | 5.112 | 19 | 7 |
| MARCH | -4.588 | 18 | 12 | 5.400 | 19 | 7 |
| APRIL | -4.196 | 17 | 12 | 5.018 | 17 | 6 |
| MAY | -3.855 | 15 | 11 | 4.390 | 2 | 18 |
| JUNE | -3.424 | 3 | 1 | 4.304 | 30 | 18 |
| JULY | -4.234 | 31 | 1 | 4.851 | 31 | 20 |
| AUGUST | -4.537 | 30 | 2 | 5.340 | 28 | 19 |
| SEPTEMBER | -4.561 | 27 | 0 | 5.470 | 27 | 19 |
| OCTOBER | -4.115 | 24 | 23 | 5.300 | 25 | 18 |
| NOVEMBER | -3.869 | 23 | 11 | 4.345 | 10 | 6 |
| DECEMBER | -3.559 | 10 | 12 | 4.242 | 23 | 6 |
| ANNUAL | -4.868 | 19 | 13 | 5.470 | 27 | 19 |

AVONMOUTH

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.676 | 21 | 16 | 13.710 | 21 | 9 |
| FEBRUARY | 0.222 | 20 | 4 | 14.200 | 20 | 9 |
| MARCH | 0.539 | 19 | 15 | 14.630 | 19 | 8 |
| APRIL | 0.686 | 16 | 14 | 14.030 | 16 | 7 |
| MAY | 1.023 | 16 | 14 | 13.070 | 3 | 20 |
| JUNE | 1.536 | 1 | 14 | 12.850 | 1 | 20 |
| JULY | 0.940 | 31 | 16 | 13.840 | 31 | 21 |
| AUGUST | 0.484 | 30 | 4 | 14.530 | 28 | 20 |
| SEPTEMBER | 0.466 | 27 | 3 | 14.490 | 27 | 20 |
| OCTOBER | 0.732 | 25 | 14 | 14.200 | 25 | 19 |
| NOVEMBER | 1.113 | 23 | 1 | 13.050 | 23 | 19 |
| ANNUAL | 0.222 | 20 | 4 | 14.630 | 19 | 8 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -5.824 | 21 | 16 | 7.210 | 21 | 9 |
| FEBRUARY | -6.278 | 20 | 4 | 7.700 | 20 | 9 |
| MARCH | -5.961 | 19 | 15 | 8.130 | 19 | 8 |
| APRIL | -5.814 | 16 | 14 | 7.530 | 16 | 7 |
| MAY | -5.477 | 16 | 14 | 6.570 | 3 | 20 |
| JUNE | -4.964 | 1 | 14 | 6.350 | 1 | 20 |
| JULY | -5.560 | 31 | 16 | 7.340 | 31 | 21 |
| AUGUST | -6.016 | 30 | 4 | 8.030 | 28 | 20 |
| SEPTEMBER | -6.034 | 27 | 3 | 7.990 | 27 | 20 |
| OCTOBER | -5.768 | 25 | 14 | 7.700 | 25 | 19 |
| NOVEMBER | -5.387 | 23 | 1 | 6.550 | 23 | 19 |
| ANNUAL | -6.278 | 20 | 4 | 8.130 | 19 | 8 |

# HOLYHEAD

## DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.194 | 21 | 18 | 6.048 | 23 | 13 |
| FEBRUARY | -0.110 | 19 | 18 | 6.037 | 1 | 10 |
| MARCH | 0.249 | 18 | 16 | 6.407 | 19 | 11 |
| APRIL | 0.493 | 15 | 15 | 6.141 | 16 | 10 |
| MAY | 0.612 | 15 | 16 | 5.658 | 1 | 22 |
| JUNE | 0.877 | 4 | 7 | 5.761 | 30 | 23 |
| JULY | 0.366 | 31 | 6 | 5.997 | 30 | 23 |
| AUGUST | 0.222 | 30 | 6 | 6.366 | 28 | 23 |
| SEPTEMBER | 0.246 | 27 | 5 | 6.447 | 27 | 23 |
| OCTOBER | 0.510 | 25 | 4 | 6.307 | 25 | 22 |
| NOVEMBER | 0.624 | 24 | 4 | 5.844 | 10 | 10 |
| DECEMBER | 0.752 | 13 | 19 | 5.792 | 23 | 10 |
| ANNUAL | -0.110 | 19 | 18 | 6.447 | 27 | 23 |

## DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.856 | 21 | 18 | 2.998 | 23 | 13 |
| FEBRUARY | -3.160 | 19 | 18 | 2.987 | 1 | 10 |
| MARCH | -2.801 | 18 | 16 | 3.357 | 19 | 11 |
| APRIL | -2.557 | 15 | 15 | 3.091 | 16 | 10 |
| MAY | -2.438 | 15 | 16 | 2.608 | 1 | 22 |
| JUNE | -2.173 | 4 | 7 | 2.711 | 30 | 23 |
| JULY | -2.684 | 31 | 6 | 2.947 | 30 | 23 |
| AUGUST | -2.828 | 30 | 6 | 3.316 | 28 | 23 |
| SEPTEMBER | -2.804 | 27 | 5 | 3.397 | 27 | 23 |
| OCTOBER | -2.540 | 25 | 4 | 3.257 | 25 | 22 |
| NOVEMBER | -2.426 | 24 | 4 | 2.794 | 10 | 10 |
| DECEMBER | -2.298 | 13 | 19 | 2.742 | 23 | 10 |
| ANNUAL | -3.160 | 19 | 18 | 3.397 | 27 | 23 |

## HEYSHAM

### DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.638 | 21 | 20 | 10.090 | 23 | 14 |
| FEBRUARY | 0.126 | 19 | 19 | 10.320 | 20 | 13 |
| MARCH | 0.348 | 18 | 18 | 10.810 | 19 | 12 |
| APRIL | 0.745 | 15 | 17 | 10.330 | 16 | 11 |
| MAY | 0.973 | 15 | 17 | 9.435 | 1 | 23 |
| JUNE | 1.420 | 4 | 8 | 9.449 | 2 | 0 |
| JULY | 0.715 | 31 | 7 | 10.090 | 31 | 0 |
| AUGUST | 0.525 | 1 | 8 | 10.820 | 29 | 0 |
| SEPTEMBER | 0.615 | 27 | 6 | 10.910 | 25 | 23 |
| OCTOBER | 0.728 | 25 | 5 | 10.450 | 25 | 23 |
| NOVEMBER | 1.059 | 23 | 5 | 9.620 | 10 | 11 |
| DECEMBER | 1.338 | 12 | 20 | 9.749 | 23 | 11 |
| ANNUAL | 0.126 | 19 | 19 | 10.910 | 25 | 23 |

### DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -4.262 | 21 | 20 | 5.190 | 23 | 14 |
| FEBRUARY | -4.774 | 19 | 19 | 5.420 | 20 | 13 |
| MARCH | -4.552 | 18 | 18 | 5.910 | 19 | 12 |
| APRIL | -4.155 | 15 | 17 | 5.430 | 16 | 11 |
| MAY | -3.927 | 15 | 17 | 4.535 | 1 | 23 |
| JUNE | -3.480 | 4 | 8 | 4.549 | 2 | 0 |
| JULY | -4.185 | 31 | 7 | 5.190 | 31 | 0 |
| AUGUST | -4.375 | 1 | 8 | 5.920 | 29 | 0 |
| SEPTEMBER | -4.285 | 27 | 6 | 6.010 | 25 | 23 |
| OCTOBER | -4.172 | 25 | 5 | 5.550 | 25 | 23 |
| NOVEMBER | -3.841 | 23 | 5 | 4.720 | 10 | 11 |
| DECEMBER | -3.562 | 12 | 20 | 4.849 | 23 | 11 |
| ANNUAL | -4.774 | 19 | 19 | 6.010 | 25 | 23 |

MILLPORT

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.111 | 21 | 20 | 4.108 | 19 | 12 |
| FEBRUARY | -0.198 | 19 | 19 | 4.675 | 9 | 16 |
| MARCH | 0.060 | 17 | 17 | 3.960 | 19 | 13 |
| APRIL | 0.182 | 15 | 17 | 3.748 | 16 | 12 |
| MAY | 0.179 | 15 | 17 | 3.530 | 2 | 12 |
| JUNE | 0.213 | 9 | 14 | 3.570 | 3 | 2 |
| JULY | 0.074 | 31 | 7 | 3.595 | 2 | 2 |
| AUGUST | -0.032 | 1 | 8 | 4.022 | 31 | 2 |
| SEPTEMBER | 0.164 | 25 | 5 | 3.999 | 28 | 1 |
| OCTOBER | 0.235 | 25 | 5 | 4.242 | 8 | 23 |
| NOVEMBER | 0.225 | 22 | 4 | 3.791 | 10 | 13 |
| DECEMBER | 0.212 | 12 | 20 | 3.890 | 26 | 14 |
| ANNUAL | -0.198 | 19 | 19 | 4.675 | 9 | 16 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -1.509 | 21 | 20 | 2.488 | 19 | 12 |
| FEBRUARY | -1.818 | 19 | 19 | 3.055 | 9 | 16 |
| MARCH | -1.560 | 17 | 17 | 2.340 | 19 | 13 |
| APRIL | -1.438 | 15 | 17 | 2.128 | 16 | 12 |
| MAY | -1.441 | 15 | 17 | 1.910 | 2 | 12 |
| JUNE | -1.407 | 9 | 14 | 1.950 | 3 | 2 |
| JULY | -1.546 | 31 | 7 | 1.975 | 2 | 2 |
| AUGUST | -1.652 | 1 | 8 | 2.402 | 31 | 2 |
| SEPTEMBER | -1.456 | 25 | 5 | 2.379 | 28 | 1 |
| OCTOBER | -1.385 | 25 | 5 | 2.622 | 8 | 23 |
| NOVEMBER | -1.395 | 22 | 4 | 2.171 | 10 | 13 |
| DECEMBER | -1.408 | 12 | 20 | 2.270 | 26 | 14 |
| ANNUAL | -1.818 | 19 | 19 | 3.055 | 9 | 16 |

ULLAPOOL

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.350 | 21 | 15 | 5.641 | 19 | 19 |
| FEBRUARY | -0.030 | 19 | 15 | 5.669 | 19 | 8 |
| MARCH | 0.249 | 17 | 13 | 5.899 | 19 | 8 |
| APRIL | 0.425 | 17 | 14 | 5.558 | 16 | 6 |
| MAY | 0.627 | 15 | 13 | 5.016 | 31 | 19 |
| JUNE | 1.017 | 5 | 4 | 5.176 | 30 | 19 |
| JULY | 0.466 | 31 | 2 | 5.600 | 30 | 20 |
| AUGUST | 0.265 | 1 | 3 | 6.031 | 29 | 20 |
| SEPTEMBER | 0.344 | 27 | 2 | 6.086 | 27 | 20 |
| OCTOBER | 0.526 | 25 | 0 | 5.766 | 26 | 19 |
| NOVEMBER | 0.720 | 23 | 0 | 5.539 | 10 | 7 |
| DECEMBER | 0.864 | 13 | 16 | 5.477 | 23 | 19 |
| ANNUAL | -0.030 | 19 | 15 | 6.086 | 27 | 20 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.400 | 21 | 15 | 2.891 | 19 | 19 |
| FEBRUARY | -2.780 | 19 | 15 | 2.919 | 19 | 8 |
| MARCH | -2.501 | 17 | 13 | 3.149 | 19 | 8 |
| APRIL | -2.325 | 17 | 14 | 2.808 | 16 | 6 |
| MAY | -2.123 | 15 | 13 | 2.266 | 31 | 19 |
| JUNE | -1.733 | 5 | 4 | 2.426 | 30 | 19 |
| JULY | -2.284 | 31 | 2 | 2.850 | 30 | 20 |
| AUGUST | -2.485 | 1 | 3 | 3.281 | 29 | 20 |
| SEPTEMBER | -2.406 | 27 | 2 | 3.336 | 27 | 20 |
| OCTOBER | -2.224 | 25 | 0 | 3.016 | 26 | 19 |
| NOVEMBER | -2.030 | 23 | 0 | 2.789 | 10 | 7 |
| DECEMBER | -1.886 | 13 | 16 | 2.727 | 23 | 19 |
| ANNUAL | -2.780 | 19 | 15 | 3.336 | 27 | 20 |

STORNOWAY

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.396 | 21 | 15 | 5.335 | 21 | 8 |
| FEBRUARY | 0.006 | 19 | 14 | 5.392 | 19 | 8 |
| MARCH | 0.291 | 18 | 13 | 5.705 | 19 | 7 |
| APRIL | 0.503 | 16 | 13 | 5.323 | 16 | 6 |
| MAY | 0.673 | 15 | 12 | 4.769 | 31 | 19 |
| JUNE | 1.027 | 5 | 4 | 4.969 | 30 | 19 |
| JULY | 0.385 | 31 | 2 | 5.238 | 30 | 20 |
| AUGUST | 0.213 | 1 | 3 | 5.048 | 1 | 21 |
| SEPTEMBER | 0.339 | 27 | 2 | 5.691 | 27 | 20 |
| OCTOBER | 0.458 | 25 | 0 | 5.436 | 26 | 19 |
| NOVEMBER | 0.653 | 23 | 0 | 5.154 | 10 | 7 |
| DECEMBER | 0.802 | 13 | 16 | 4.943 | 23 | 7 |
| ANNUAL | 0.006 | 19 | 14 | 5.705 | 19 | 7 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.314 | 21 | 15 | 2.625 | 21 | 8 |
| FEBRUARY | -2.704 | 19 | 14 | 2.682 | 19 | 8 |
| MARCH | -2.419 | 18 | 13 | 2.995 | 19 | 7 |
| APRIL | -2.207 | 16 | 13 | 2.613 | 16 | 6 |
| MAY | -2.037 | 15 | 12 | 2.059 | 31 | 19 |
| JUNE | -1.683 | 5 | 4 | 2.259 | 30 | 19 |
| JULY | -2.325 | 31 | 2 | 2.528 | 30 | 20 |
| AUGUST | -2.497 | 1 | 3 | 2.338 | 1 | 21 |
| SEPTEMBER | -2.371 | 27 | 2 | 2.981 | 27 | 20 |
| OCTOBER | -2.252 | 25 | 0 | 2.726 | 26 | 19 |
| NOVEMBER | -2.057 | 23 | 0 | 2.444 | 10 | 7 |
| DECEMBER | -1.908 | 13 | 16 | 2.233 | 23 | 7 |
| ANNUAL | -2.704 | 19 | 14 | 2.995 | 19 | 7 |

WICK

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.231 | 21 | 19 | 4.028 | 20 | 12 |
| FEBRUARY | -0.114 | 19 | 19 | 3.777 | 18 | 12 |
| MARCH | 0.428 | 4 | 18 | 3.431 | 15 | 22 |
| APRIL | 0.299 | 16 | 17 | 3.750 | 15 | 10 |
| MAY | 0.354 | 14 | 16 | 3.387 | 31 | 23 |
| JUNE | 0.551 | 8 | 12 | 3.441 | 3 | 1 |
| JULY | 0.248 | 31 | 7 | 3.715 | 31 | 0 |
| AUGUST | 0.138 | 1 | 7 | 4.096 | 27 | 23 |
| SEPTEMBER | 0.269 | 27 | 6 | 4.199 | 28 | 0 |
| OCTOBER | 0.283 | 24 | 4 | 4.045 | 27 | 0 |
| NOVEMBER | 0.483 | 21 | 3 | 3.846 | 11 | 12 |
| DECEMBER | 0.496 | 13 | 20 | 3.791 | 22 | 10 |
| ANNUAL | -0.114 | 19 | 19 | 4.199 | 28 | 0 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -1.479 | 21 | 19 | 2.318 | 20 | 12 |
| FEBRUARY | -1.824 | 19 | 19 | 2.067 | 18 | 12 |
| MARCH | -1.282 | 4 | 18 | 1.721 | 15 | 22 |
| APRIL | -1.411 | 16 | 17 | 2.040 | 15 | 10 |
| MAY | -1.356 | 14 | 16 | 1.677 | 31 | 23 |
| JUNE | -1.159 | 8 | 12 | 1.731 | 3 | 1 |
| JULY | -1.462 | 31 | 7 | 2.005 | 31 | 0 |
| AUGUST | -1.572 | 1 | 7 | 2.386 | 27 | 23 |
| SEPTEMBER | -1.441 | 27 | 6 | 2.489 | 28 | 0 |
| OCTOBER | -1.427 | 24 | 4 | 2.335 | 27 | 0 |
| NOVEMBER | -1.227 | 21 | 3 | 2.136 | 11 | 12 |
| DECEMBER | -1.214 | 13 | 20 | 2.081 | 22 | 10 |
| ANNUAL | -1.824 | 19 | 19 | 2.489 | 28 | 0 |

## ABERDEEN

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.186 | 19 | 20 | 4.792 | 20 | 14 |
| FEBRUARY | -0.154 | 19 | 21 | 4.631 | 18 | 14 |
| MARCH | -0.128 | 18 | 20 | 4.882 | 20 | 15 |
| APRIL | 0.311 | 16 | 19 | 4.581 | 17 | 14 |
| MAY | 0.473 | 15 | 19 | 4.158 | 3 | 14 |
| JUNE | 0.732 | 5 | 11 | 4.222 | 3 | 3 |
| JULY | 0.274 | 31 | 9 | 4.525 | 31 | 2 |
| AUGUST | 0.209 | 1 | 9 | 4.911 | 30 | 3 |
| SEPTEMBER | 0.124 | 27 | 8 | 5.025 | 28 | 2 |
| OCTOBER | 0.299 | 25 | 7 | 4.968 | 27 | 2 |
| NOVEMBER | 0.636 | 21 | 5 | 4.525 | 11 | 14 |
| DECEMBER | 0.634 | 12 | 21 | 4.705 | 22 | 13 |
| ANNUAL | -0.154 | 19 | 21 | 5.025 | 28 | 2 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.064 | 19 | 20 | 2.542 | 20 | 14 |
| FEBRUARY | -2.404 | 19 | 21 | 2.381 | 18 | 14 |
| MARCH | -2.378 | 18 | 20 | 2.632 | 20 | 15 |
| APRIL | -1.939 | 16 | 19 | 2.331 | 17 | 14 |
| MAY | -1.777 | 15 | 19 | 1.908 | 3 | 14 |
| JUNE | -1.518 | 5 | 11 | 1.972 | 3 | 3 |
| JULY | -1.976 | 31 | 9 | 2.275 | 31 | 2 |
| AUGUST | -2.041 | 1 | 9 | 2.661 | 30 | 3 |
| SEPTEMBER | -2.126 | 27 | 8 | 2.775 | 28 | 2 |
| OCTOBER | -1.951 | 25 | 7 | 2.718 | 27 | 2 |
| NOVEMBER | -1.614 | 21 | 5 | 2.275 | 11 | 14 |
| DECEMBER | -1.616 | 12 | 21 | 2.455 | 22 | 13 |
| ANNUAL | -2.404 | 19 | 21 | 2.775 | 28 | 2 |

NORTH SHIELDS

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.031 | 19 | 22 | 5.567 | 20 | 16 |
| FEBRUARY | -0.149 | 19 | 23 | 5.540 | 18 | 16 |
| MARCH | -0.335 | 18 | 22 | 5.727 | 20 | 17 |
| APRIL | 0.237 | 16 | 22 | 5.449 | 17 | 16 |
| MAY | 0.546 | 15 | 21 | 4.970 | 3 | 16 |
| JUNE | 0.829 | 15 | 10 | 5.007 | 30 | 16 |
| JULY | 0.263 | 31 | 11 | 5.357 | 31 | 4 |
| AUGUST | 0.051 | 29 | 11 | 5.729 | 30 | 5 |
| SEPTEMBER | 0.026 | 27 | 10 | 5.815 | 28 | 4 |
| OCTOBER | 0.064 | 26 | 10 | 5.779 | 27 | 4 |
| NOVEMBER | 0.703 | 23 | 9 | 5.233 | 11 | 16 |
| DECEMBER | 0.660 | 13 | 0 | 5.450 | 24 | 4 |
| ANNUAL | -0.335 | 18 | 22 | 5.815 | 28 | 4 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.569 | 19 | 22 | 2.967 | 20 | 16 |
| FEBRUARY | -2.749 | 19 | 23 | 2.940 | 18 | 16 |
| MARCH | -2.935 | 18 | 22 | 3.127 | 20 | 17 |
| APRIL | -2.363 | 16 | 22 | 2.849 | 17 | 16 |
| MAY | -2.054 | 15 | 21 | 2.370 | 3 | 16 |
| JUNE | -1.771 | 15 | 10 | 2.407 | 30 | 16 |
| JULY | -2.337 | 31 | 11 | 2.757 | 31 | 4 |
| AUGUST | -2.549 | 29 | 11 | 3.129 | 30 | 5 |
| SEPTEMBER | -2.574 | 27 | 10 | 3.215 | 28 | 4 |
| OCTOBER | -2.536 | 26 | 10 | 3.179 | 27 | 4 |
| NOVEMBER | -1.897 | 23 | 9 | 2.633 | 11 | 16 |
| DECEMBER | -1.940 | 13 | 0 | 2.850 | 24 | 4 |
| ANNUAL | -2.935 | 18 | 22 | 3.215 | 28 | 4 |

IMMINGHAM

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.407 | 20 | 1 | 7.669 | 20 | 19 |
| FEBRUARY | 0.033 | 20 | 2 | 7.703 | 20 | 20 |
| MARCH | -0.227 | 19 | 1 | 8.029 | 20 | 19 |
| APRIL | 0.554 | 17 | 0 | 7.685 | 17 | 18 |
| MAY | 0.906 | 16 | 0 | 7.177 | 15 | 17 |
| JUNE | 1.213 | 2 | 13 | 7.062 | 4 | 8 |
| JULY | 0.474 | 31 | 14 | 7.598 | 31 | 7 |
| AUGUST | 0.300 | 29 | 14 | 8.048 | 28 | 6 |
| SEPTEMBER | 0.124 | 27 | 13 | 8.123 | 28 | 7 |
| OCTOBER | 0.251 | 26 | 13 | 7.948 | 27 | 7 |
| NOVEMBER | 1.155 | 9 | 12 | 7.327 | 24 | 6 |
| DECEMBER | 1.078 | 25 | 1 | 7.616 | 24 | 7 |
| ANNUAL | -0.227 | 19 | 1 | 8.123 | 28 | 7 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -3.493 | 20 | 1 | 3.769 | 20 | 19 |
| FEBRUARY | -3.867 | 20 | 2 | 3.803 | 20 | 20 |
| MARCH | -4.127 | 19 | 1 | 4.129 | 20 | 19 |
| APRIL | -3.346 | 17 | 0 | 3.785 | 17 | 18 |
| MAY | -2.994 | 16 | 0 | 3.277 | 15 | 17 |
| JUNE | -2.687 | 2 | 13 | 3.162 | 4 | 8 |
| JULY | -3.426 | 31 | 14 | 3.698 | 31 | 7 |
| AUGUST | -3.600 | 29 | 14 | 4.148 | 28 | 6 |
| SEPTEMBER | -3.776 | 27 | 13 | 4.223 | 28 | 7 |
| OCTOBER | -3.649 | 26 | 13 | 4.048 | 27 | 7 |
| NOVEMBER | -2.745 | 9 | 12 | 3.427 | 24 | 6 |
| DECEMBER | -2.822 | 25 | 1 | 3.716 | 24 | 7 |
| ANNUAL | -4.127 | 19 | 1 | 4.223 | 28 | 7 |

## LOWESTOFT

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -0.139 | 20 | 4 | 2.920 | 20 | 22 |
| FEBRUARY | -0.004 | 20 | 6 | 3.192 | 28 | 19 |
| MARCH | -0.459 | 19 | 5 | 3.119 | 16 | 20 |
| APRIL | 0.092 | 15 | 2 | 2.779 | 17 | 22 |
| MAY | 0.321 | 13 | 1 | 2.575 | 14 | 20 |
| JUNE | 0.388 | 6 | 20 | 2.621 | 4 | 12 |
| JULY | 0.201 | 5 | 20 | 2.732 | 29 | 9 |
| AUGUST | 0.024 | 27 | 15 | 3.135 | 28 | 9 |
| SEPTEMBER | -0.042 | 27 | 17 | 3.102 | 29 | 11 |
| OCTOBER | -0.170 | 26 | 16 | 3.029 | 27 | 10 |
| NOVEMBER | 0.330 | 9 | 15 | 2.984 | 29 | 0 |
| DECEMBER | 0.288 | 25 | 5 | 3.371 | 24 | 10 |
| ANNUAL | -0.459 | 19 | 5 | 3.371 | 24 | 10 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -1.639 | 20 | 4 | 1.420 | 20 | 22 |
| FEBRUARY | -1.504 | 20 | 6 | 1.692 | 28 | 19 |
| MARCH | -1.959 | 19 | 5 | 1.619 | 16 | 20 |
| APRIL | -1.408 | 15 | 2 | 1.279 | 17 | 22 |
| MAY | -1.179 | 13 | 1 | 1.075 | 14 | 20 |
| JUNE | -1.112 | 6 | 20 | 1.121 | 4 | 12 |
| JULY | -1.299 | 5 | 20 | 1.232 | 29 | 9 |
| AUGUST | -1.476 | 27 | 15 | 1.635 | 28 | 9 |
| SEPTEMBER | -1.542 | 27 | 17 | 1.602 | 29 | 11 |
| OCTOBER | -1.670 | 26 | 16 | 1.529 | 27 | 10 |
| NOVEMBER | -1.170 | 9 | 15 | 1.484 | 29 | 0 |
| DECEMBER | -1.212 | 25 | 5 | 1.871 | 24 | 10 |
| ANNUAL | -1.959 | 19 | 5 | 1.871 | 24 | 10 |

## SHEERNESS

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.181 | 20 | 7 | 6.294 | 22 | 15 |
| FEBRUARY | -0.002 | 20 | 9 | 6.249 | 19 | 14 |
| MARCH | -0.429 | 19 | 8 | 6.329 | 21 | 2 |
| APRIL | 0.220 | 17 | 7 | 6.076 | 18 | 1 |
| MAY | 0.550 | 15 | 6 | 5.858 | 17 | 1 |
| JUNE | 0.585 | 2 | 20 | 5.809 | 4 | 3 |
| JULY | 0.227 | 30 | 20 | 5.951 | 30 | 1 |
| AUGUST | 0.061 | 30 | 21 | 6.129 | 30 | 2 |
| SEPTEMBER | -0.127 | 27 | 20 | 6.458 | 27 | 1 |
| OCTOBER | 0.081 | 26 | 20 | 6.141 | 10 | 0 |
| NOVEMBER | 0.589 | 9 | 18 | 5.814 | 11 | 13 |
| DECEMBER | 0.450 | 13 | 9 | 6.718 | 24 | 13 |
| ANNUAL | -0.429 | 19 | 8 | 6.718 | 24 | 13 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -2.719 | 20 | 7 | 3.394 | 22 | 15 |
| FEBRUARY | -2.902 | 20 | 9 | 3.349 | 19 | 14 |
| MARCH | -3.329 | 19 | 8 | 3.429 | 21 | 2 |
| APRIL | -2.680 | 17 | 7 | 3.176 | 18 | 1 |
| MAY | -2.350 | 15 | 6 | 2.958 | 17 | 1 |
| JUNE | -2.315 | 2 | 20 | 2.909 | 4 | 3 |
| JULY | -2.673 | 30 | 20 | 3.051 | 30 | 1 |
| AUGUST | -2.839 | 30 | 21 | 3.229 | 30 | 2 |
| SEPTEMBER | -3.027 | 27 | 20 | 3.558 | 27 | 1 |
| OCTOBER | -2.819 | 26 | 20 | 3.241 | 10 | 0 |
| NOVEMBER | -2.311 | 9 | 18 | 2.914 | 11 | 13 |
| DECEMBER | -2.450 | 13 | 9 | 3.818 | 24 | 13 |
| ANNUAL | -3.329 | 19 | 8 | 3.818 | 24 | 13 |

## DOVER

DATUM = DATUM OF DATA

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | 0.524 | 20 | 7 | 7.145 | 21 | 0 |
| FEBRUARY | 0.193 | 20 | 8 | 7.219 | 19 | 12 |
| MARCH | -0.079 | 19 | 7 | 7.339 | 21 | 1 |
| APRIL | 0.453 | 17 | 7 | 7.064 | 18 | 0 |
| MAY | 0.790 | 16 | 6 | 6.711 | 14 | 22 |
| JUNE | 1.007 | 2 | 7 | 6.533 | 1 | 11 |
| JULY | 0.483 | 31 | 20 | 6.865 | 31 | 13 |
| AUGUST | 0.306 | 29 | 20 | 7.338 | 28 | 11 |
| SEPTEMBER | 0.284 | 27 | 19 | 7.255 | 29 | 13 |
| OCTOBER | 0.962 | 13 | 20 | 6.711 | 10 | 11 |
| ANNUAL | -0.079 | 19 | 7 | 7.339 | 21 | 1 |

DATUM = ORDNANCE DATUM (NEWLYN)

| MONTH | MINIMA HEIGHT | DAY | HR. | MAXIMA HEIGHT | DAY | HR. |
|---|---|---|---|---|---|---|
| JANUARY | -3.146 | 20 | 7 | 3.475 | 21 | 0 |
| FEBRUARY | -3.477 | 20 | 8 | 3.549 | 19 | 12 |
| MARCH | -3.749 | 19 | 7 | 3.669 | 21 | 1 |
| APRIL | -3.217 | 17 | 7 | 3.394 | 18 | 0 |
| MAY | -2.880 | 16 | 6 | 3.041 | 14 | 22 |
| JUNE | -2.663 | 2 | 7 | 2.863 | 1 | 11 |
| JULY | -3.187 | 31 | 20 | 3.195 | 31 | 13 |
| AUGUST | -3.364 | 29 | 20 | 3.668 | 28 | 11 |
| SEPTEMBER | -3.386 | 27 | 19 | 3.585 | 29 | 13 |
| OCTOBER | -2.708 | 13 | 20 | 3.041 | 10 | 11 |
| ANNUAL | -3.749 | 19 | 7 | 3.669 | 21 | 1 |

## 3.2 MEAN SEA LEVEL VALUES

The following table shows monthly mean sea level values for each site as computed using Doodson's Xo filter with a central time of 1200 GMT. Suffixes in the table denote the number of missing days in any month. Where 16 or more days are missing, the monthly value is not included, and the Annual mean is weighted accordingly, following the standard practice of Permanent Service for Mean Sea Level (PSMSL).

It should be noted that these values are presented relative to local Chart Datum at each site and NOT to Revised Local Reference (RLR) as used by PSMSL and therefore cannot be directly compared with long period values from that source.

In the table on page 90,and in graphical form on the following page,the monthly mean sea level values are presented as anomalies relative to the Annual figure.

This dispenses with any influence the Land Levelling system may have on the results and therefore these show the meteorological influences through the year,as what may be viewed as a mirror image of atmospheric pressure.

## MONTHLY MEAN SEA LEVEL VALUES TO CHART DATUM

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEWLYN | 3.325 | 3.148 | 3.106 | 3.154 | 3.212 | 3.164 | 3.197 | 3.180 | 3.163 | 3.287 | 3.271 | 3.125 | 3.194 |
| ILFRACOMBE | 5.148 | 4.965 | 4.924 | 4.904 | 4.979 | 4.922 | 5.011 | 4.987 | 4.980 | 5.073 | 5.035 | 4.935 | 4.989 |
| AVONMOUTH | 7.092 | 6.958 | 6.966 08 | 6.792 04 | 6.884 | 6.819 | 6.978 | 6.960 | 6.958 | 6.973 | 6.906 07 | xxx 31 | 6.935 |
| HOLYHEAD | 3.434 | 3.231 | 3.172 | 3.146 | 3.224 | 3.166 | 3.291 | 3.268 | 3.252 | 3.343 | 3.320 | 3.238 | 3.257 |
| HEYSHAM | 5.366 | 5.226 | 5.116 | 5.028 | 5.102 | 5.053 | 5.226 05 | 5.206 | 5.189 | 5.233 | 5.193 | 5.183 | 5.177 |
| MILLPORT | 2.220 | 2.021 | 1.948 | 1.891 | 1.950 | 1.889 | 2.055 03 | 2.052 | 2.024 | 2.091 | 2.077 | 2.041 | 2.022 |
| ULLAPOOL | 3.195 06 | 3.063 | 3.016 | 2.935 | 2.974 | 2.945 | 3.102 03 | 3.141 | 3.139 | 3.144 | 3.176 | 3.167 | 3.083 |
| STORNOWAY | 3.069 | 2.908 | 2.877 | 2.809 | 2.868 | 2.838 | 2.938 02 | 2.915 10 | 2.914 15 | 2.945 | 2.979 | 2.951 | 2.917 |
| WICK | 2.190 | 2.039 | 1.941 10 | 1.889 | 1.924 | 1.924 | 2.036 08 | 2.075 04 | 2.102 | 2.074 06 | 2.140 | 2.137 | 2.039 |
| ABERDEEN | 2.668 | 2.561 | 2.498 | 2.410 | 2.440 | 2.455 | 2.563 | 2.587 | 2.610 | 2.587 | 2.651 | 2.659 03 | 2.557 |
| NORTH SHIELDS | 3.029 | 2.958 | 2.892 03 | 2.818 07 | 2.843 | 2.864 | 2.942 | 2.956 | 2.986 | 2.957 | 3.038 | 3.024 02 | 2.942 |
| IMMINGHAM | 4.211 | 4.170 | 4.149 | 4.082 | 4.123 | 4.155 | 4.170 | 4.194 | 4.244 | 4.219 | 4.321 | 4.281 | 4.193 |
| LOWESTOFT | 1.649 | 1.676 | 1.628 | 1.505 | 1.548 | 1.611 | 1.605 | 1.639 | 1.681 | 1.618 | 1.727 | 1.734 | 1.635 |
| SHEERNESS | 3.022 | 3.023 | 3.025 | 2.982 | 2.989 | 3.054 | 2.974 | 3.028 | 3.064 | 3.035 | 3.144 | 3.108 | 3.037 |
| DOVER | 3.817 | 3.779 | 3.749 | 3.621 | 3.691 | 3.717 | 3.732 | 3.752 | 3.788 | xxx 16 | xxx 30 | xxx 31 | 3.738 |

# MONTHLY MEAN SEA LEVEL ANOMALIES

(MONTHLY MEAN - ANNUAL MEAN)

(MMS)

## WEST COAST (N - S)

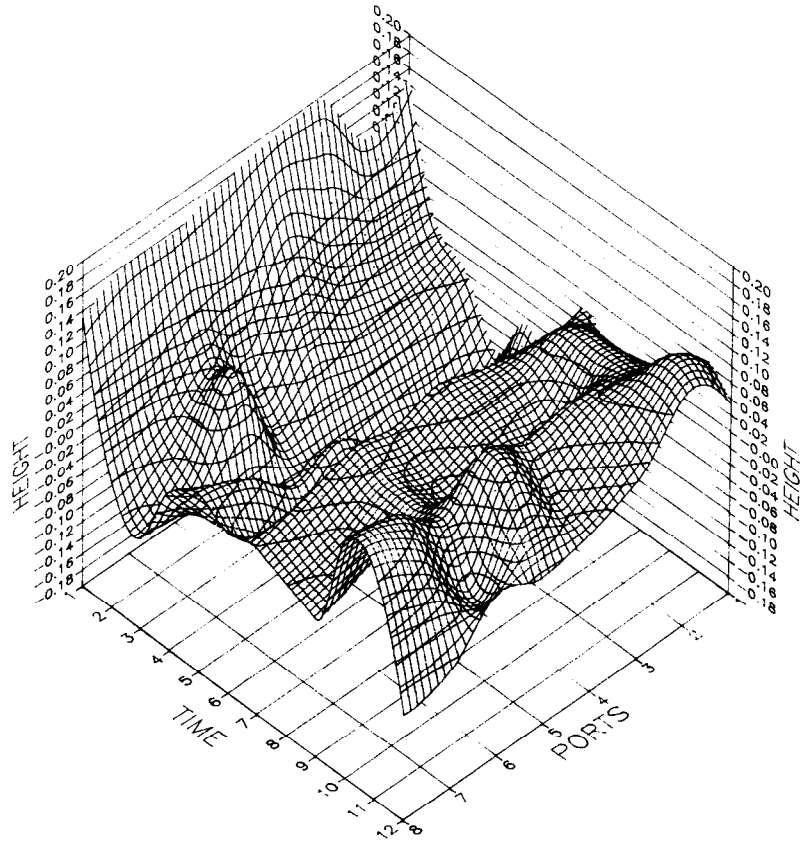
| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 STORNOWAY | 152 | -009 | -040 | -108 | -049 | -079 | 021 | -002 | -003 | 028 | 062 | 034 |
| 1.2 ULLAPOOL | 112 | -020 | -067 | -148 | -109 | -138 | 019 | 058 | 056 | 061 | 093 | 084 |
| 1.3 MILLPORT | 198 | -001 | -074 | -131 | -072 | -133 | 033 | 030 | 002 | 069 | 055 | 019 |
| 1.4 HEYSHAM | 189 | 049 | -061 | -149 | -075 | -124 | 049 | 029 | 012 | 056 | 016 | 006 |
| 1.5 HOLYHEAD | 177 | -026 | -085 | -111 | -033 | -091 | 034 | 011 | -005 | 086 | 063 | -019 |
| 1.6 AVONMOUTH | 157 | 023 | 031 | -143 | -051 | -116 | 043 | 025 | 023 | 038 | -029 | |
| 1.7 ILFRACOMBE | 159 | -024 | -065 | -085 | -001 | -067 | 022 | -002 | -009 | 084 | 046 | -054 |
| 1.8 NEWLYN | 131 | -046 | -088 | -004 | 018 | -003 | 003 | -014 | -031 | 093 | 077 | -069 |

## EAST COAST (N - S)

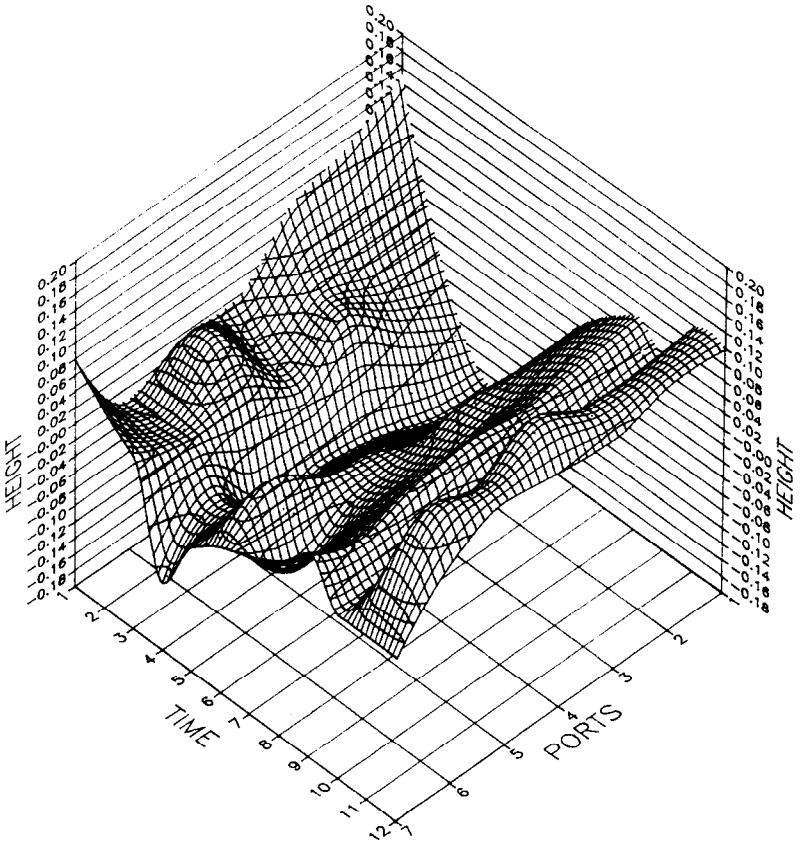
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.1 WICK | 151 | 000 | -098 | -150 | -115 | -115 | -003 | 036 | 063 | 035 | 101 | 098 |
| 2.2 ABERDEEN | 111 | 004 | -059 | -147 | -117 | -102 | 006 | 030 | 053 | 030 | 094 | 102 |
| 2.3 NORTH SHIELDS | 087 | 016 | -005 | -124 | -099 | -078 | 000 | 014 | 044 | 015 | 096 | 082 |
| 2.4 IMMINGHAM | 018 | -023 | -044 | -111 | -070 | -038 | -023 | 001 | 051 | 026 | 128 | 088 |
| 2.5 LOWESTOFT | 014 | 041 | -007 | -130 | -087 | -024 | -030 | 004 | 046 | -017 | 092 | 099 |
| 2.6 SHEERNESS | -015 | -014 | -012 | -055 | -048 | 017 | -063 | -009 | 027 | -002 | 107 | 071 |
| 2.7 DOVER | 079 | 041 | 011 | -117 | -047 | -021 | -006 | 014 | 050 | | | |

VALUES ARE DEPICTED IN GRAPHICAL FORM
ON THE PAGE OPPOSITE
(PORT NUMBERS RELATE TO THOSE ON THE DIAGRAMS)

Mean Sea Level Anomalies 1988 -- West Coast




Mean Sea Level Anomalies 1988 -- East Coast



3.3 STORM SURGE RESIDUALS

The difference between gauge recordings and predicted levels, depending on the quality of the predictions leave a 'residual' tide which reflects the meteorological influence with some local effects due to the topography and/or instrument errors.

The following pages show these differences whereby the effects on coastal sea levels may be 'tracked' from port to port.

These are positive or negative anomalies termed storm surges as they are generally associated with storms and inclement weather.

It is emphasised that the values are from hourly still water levels ie. not including wave effects.

Predominant surges in excess of 1m observed in 1988 were :

a) January 6

A positive surge increasing in magnitude up the Severn Estuary,(1.34m at Avonmouth at 0700GMT), is followed by a negative surge (maximum -1.098m at Sheerness), as a depression tracked NE across England,accompanied by strong Westerly winds especially in the South.A gust of 78kts was recorded at Mumbles.

b) January 19-20

A negative surge (maximum -0.79m at Immingham) followed by a 'recovery' positive surge evident on all East Coast records (maximum 0.69m at Immingham) caused by a deep depression moving across Ireland to Cape Wrath,which then tracked Northwards over Faeroes.An associated trough moved Eastwards across England.

c) February 9-10

Very strong westerly winds associated with a complex low pressure system with it's main centre tracking over Northern Scotland produced a positive surge on West coast sites (maximum 2.42m at Heysham) and negative surges on

the East coast (-0.98m at Dover;-1.36m at Sheerness)
Gusts to 96kts were reported in the Land's End area.
As the depression continued to Southern Norway, positive surges were evident on all East coast records (1.03m at Sheerness)

d) February 13
A negative surge with maximum at Sheerness (-1.525m) caused by a complex low pressure system wich moved NNE'wards to the West of Scotland then re-curved towards Iceland,it's passage blocked by an anti-cyclone developing over central Europe.

e) February 28-29
A positive surge of over 1m at Dover,Sheerness,Lowestoft and Immingham with a maximum of 1.593m at Sheerness.
A slow moving depression moved from the Norwegian coast to the Skagerrak. This combined with a Mid-Atlantic High (1034mb), gave a strong NW gradient over the North Sea.

f) March 7
Positive surge of 1.045m at Sheerness.
Filling depression (992mb) moved slowly down the Eastern side of the North Sea to Poland (1000mb).This acted in conjunction with the Azores High.

g) March 15-16
A complex low pressure system over Ireland and Northern England combined into a single centre that tracked eastwards to Southern Denmark.
The surge effect is evident on all records (maximum 1.39m at Avonmouth)

h) March 24-25
A depression centred over Northern Scotland with a secondary centre crossing southern Britain caused surges of maximum 1.43m at Avonmouth on the West coast and 0.88m at Dover in the East.

i) September 23-24

A complex low with associated fronts tracking East from North of Ireland to Scandinavia.A secondary centre developed in the Irish Sea by 0001 GMT 24th (990mb), tracking East with main depression.

Gusts up to 60kts were reported at Fleetwood.

Maximum surges of 1.05m (0800GMT 23rd) and 1.09m (0300GMT 24th) were recorded at Heysham, with smaller responses evident on East coast records.

j) 26 September

Strong westerly regime in the warm sector associated with a deepening low (double centre) tracking Eastwards just to the North of Scotland caused a negative surge of 1.017m at Sheerness with lesser effects on other East coast records.

k) October 6-7

Positive surges of 1.245m (2200GMT 6th) and 1.10m (1000GMT 7th) at Avonmouth with lesser effects on all other gauge records were caused by a deep depression 120nm East of Wick which moved North and deepened. Just North of 61deg it turned SSW passing just West of Shetland and Fair Isle. A shallow secondary depression moved east over Central Scotland in the evening passing into the Northern North Sea.

Gusts of 65kts were reported at Aberporth,South Wales.

l) October 9

Strong SW'lies associated with a deep low moving Eastwards across N.Scotland caused surges of over 1m at Heysham and Millport (max. 1.108m at Millport). Smaller effects evident on other Northern records on the West coast and all East coast gauges.

m) November 18

Positive surge of 1.021m at Sheerness.No record available for Dover.

A shallow depression moved East over Southern Scotland and on towards Denmark An associated trough moved South over the UK bringing a strong NE'ly gradient down the East coast.

n) December 4

Positive surge 1.041m at Heysham. No record available for Avonmouth.
A deep depression tracked NE over Northern Scotland with strong West to SWly winds behind an occluded front.

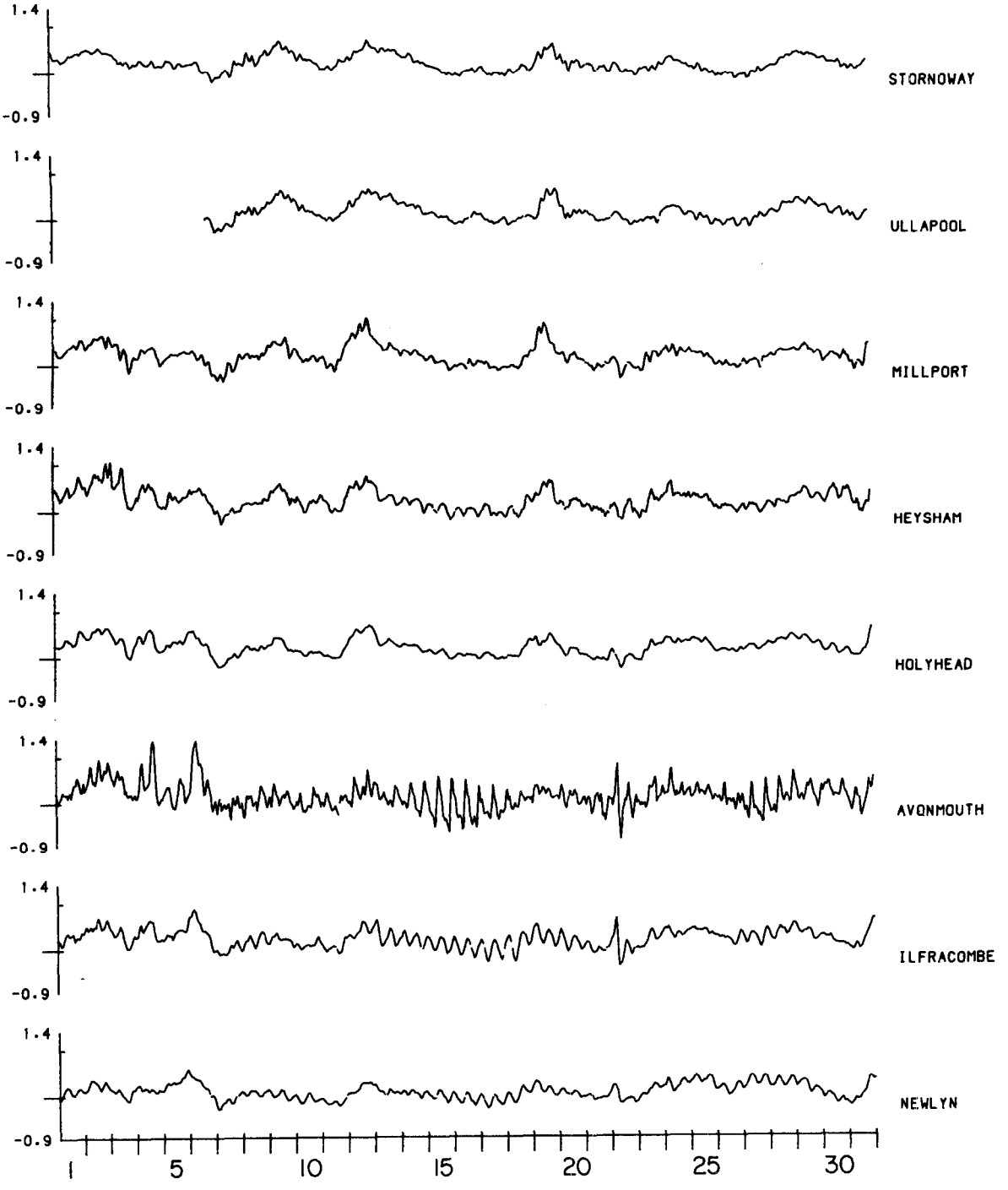
o) December 22

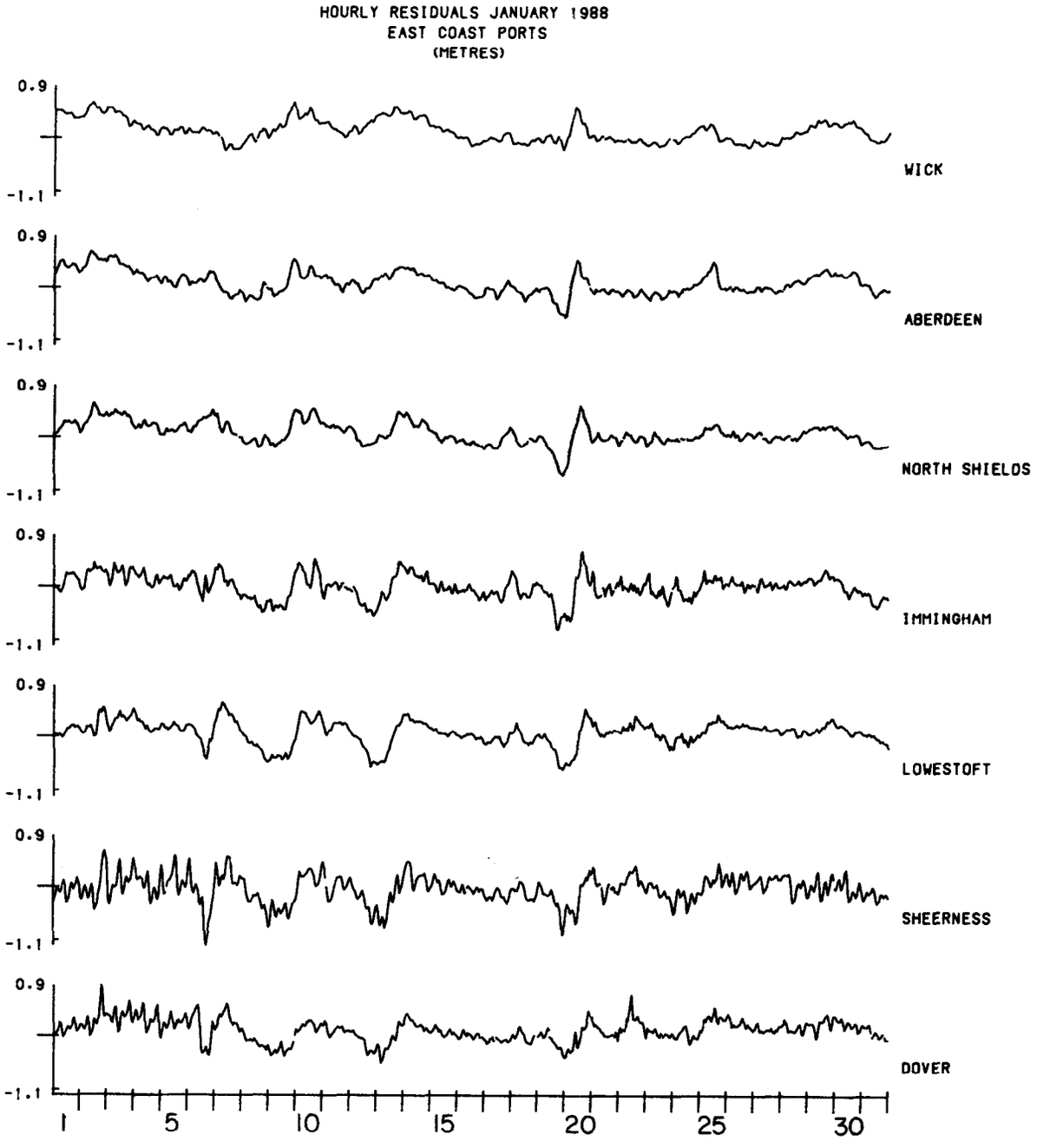
Surge of 1.09m at Immingham,1.00m at Sheerness.
Deep depression moved ENE passing North of Faeroes towards Northern Scandinavia.Associated cold front moved SE into British Isles reaching as far south as the Wash before returning slowly northwards.

p) December 24

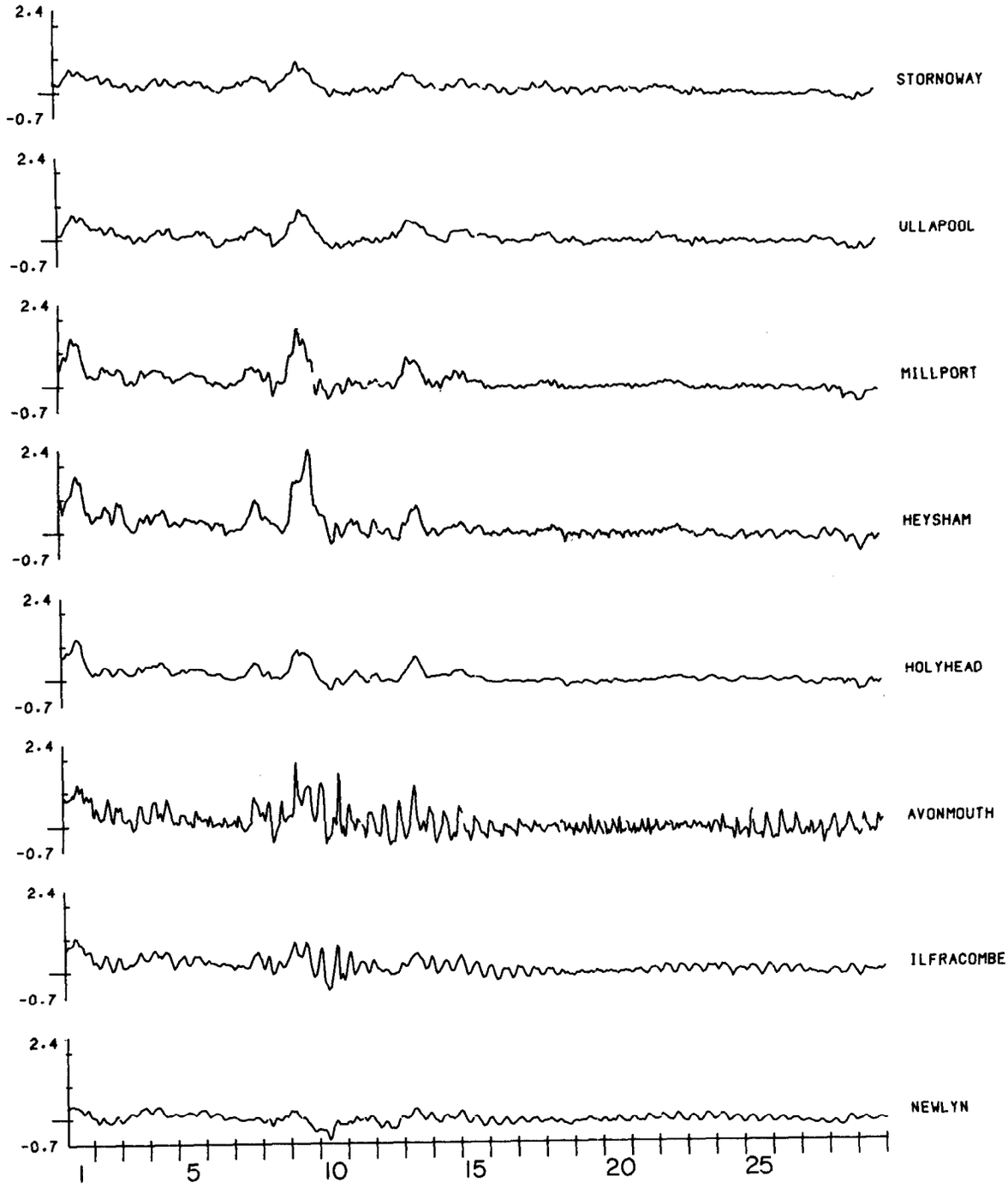
Positive surges of 1.25m at Lowestoft and over 1m at both Sheerness and Immingham were recorded.No record available for Dover.
A complex depression tracked Eastwards passing just North of Shetland.
An associated trough moved SE over North Sea in synchronisation with warm front wave which moved East from Western Ireland crossing northern Norfolk and on into the Low Countries.

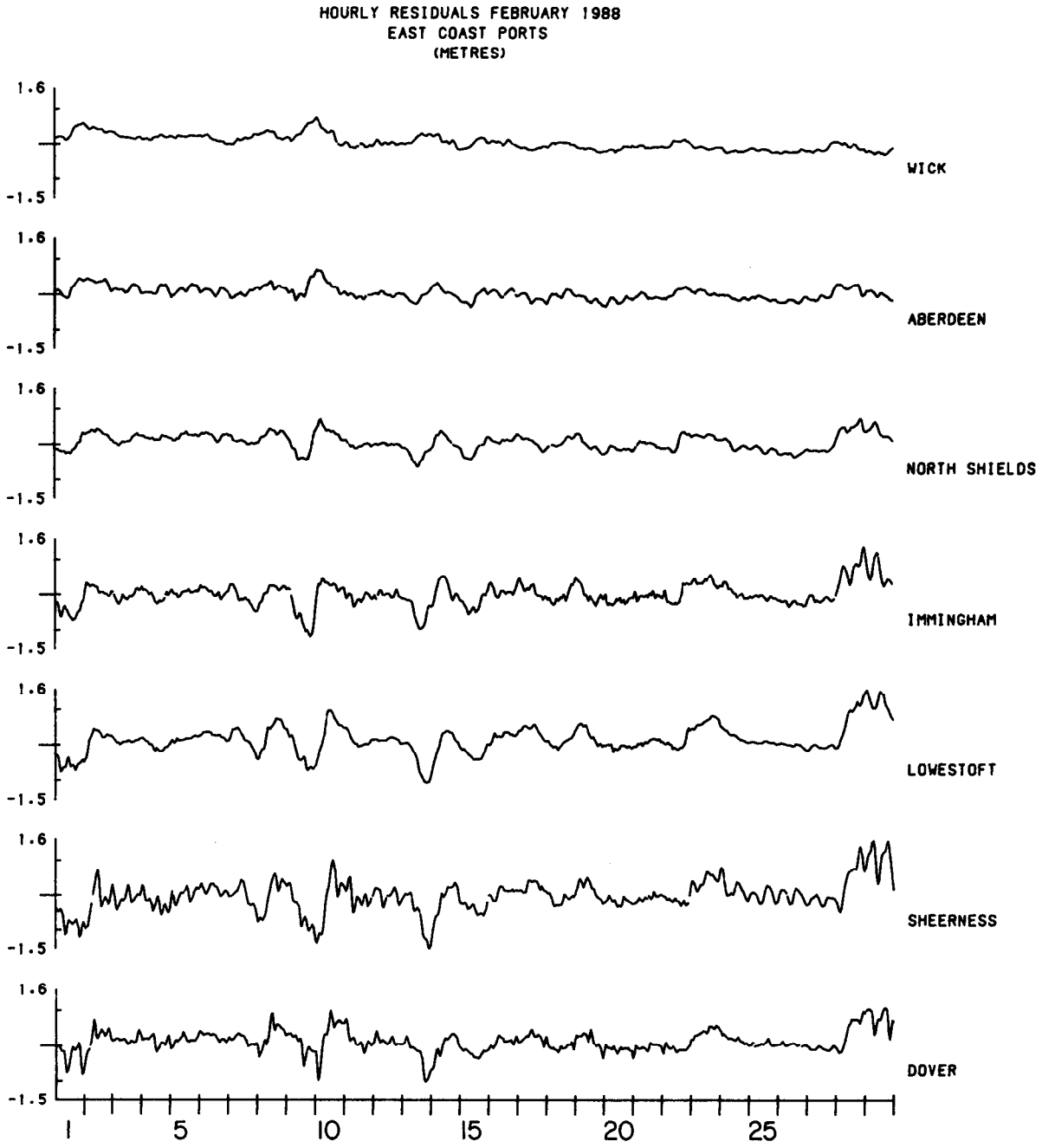
HOURLY RESIDUALS JANUARY 1988
WEST COAST PORTS
(METRES)



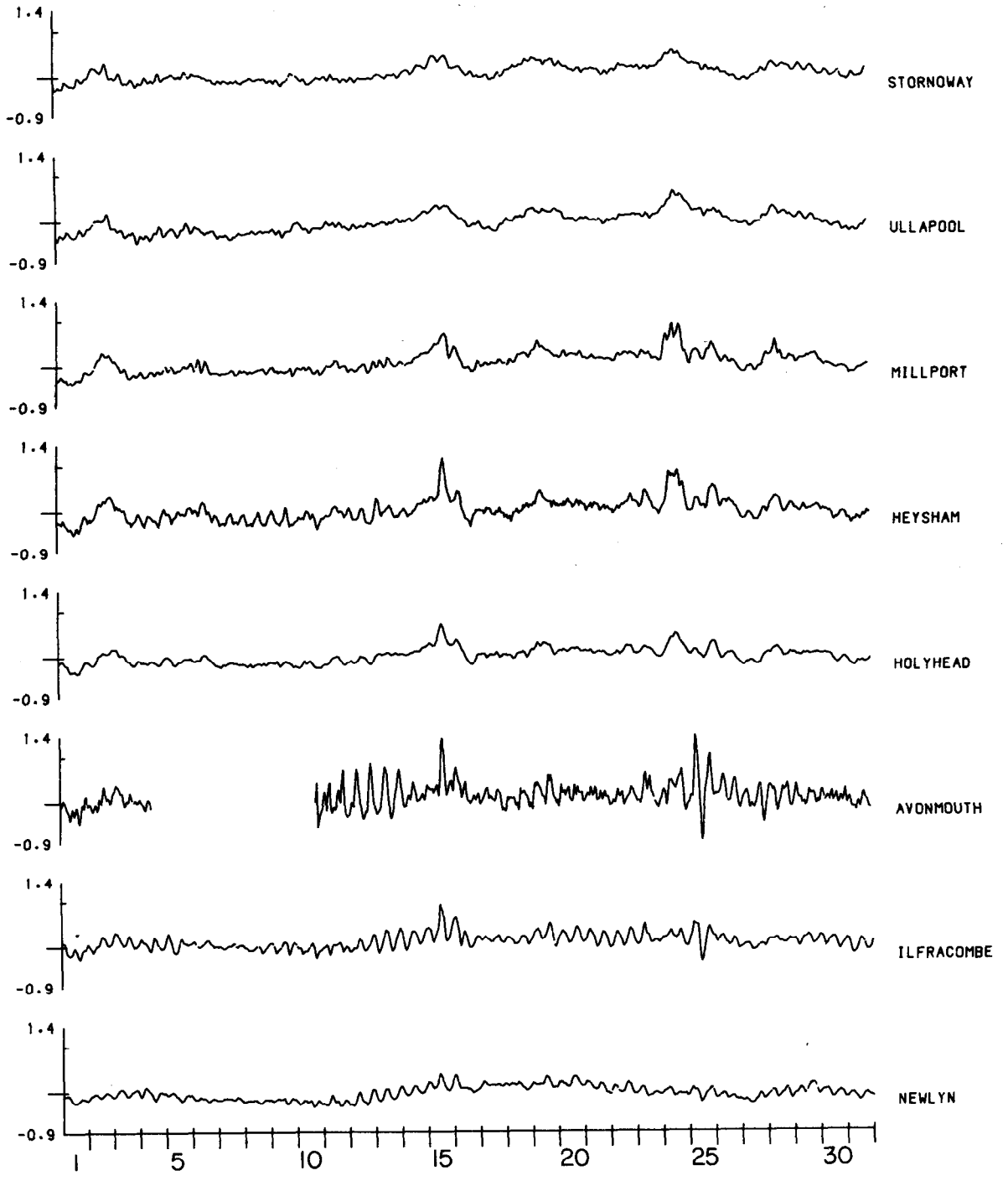

HOURLY RESIDUALS JANUARY 1988
EAST COAST PORTS
(METRES)
0.9
-1.1
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER
1
5
10
15
20
25
30

HOURLY RESIDUALS FEBRUARY 1988
WEST COAST PORTS
(METRES)

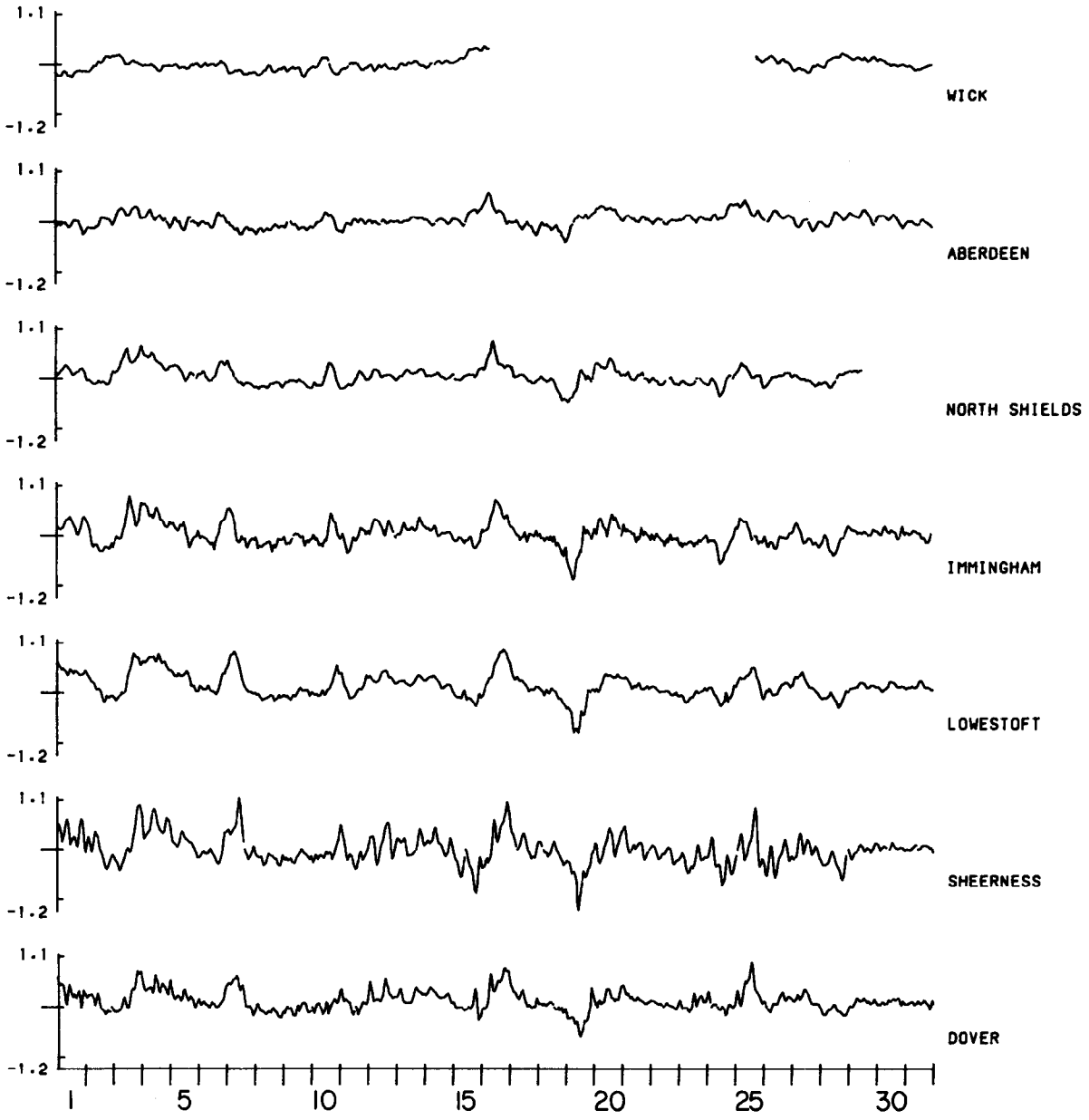



HOURLY RESIDUALS FEBRUARY 1988
EAST COAST PORTS
(METRES)
1.6
-1.5
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER
1
5
10
15
20
25

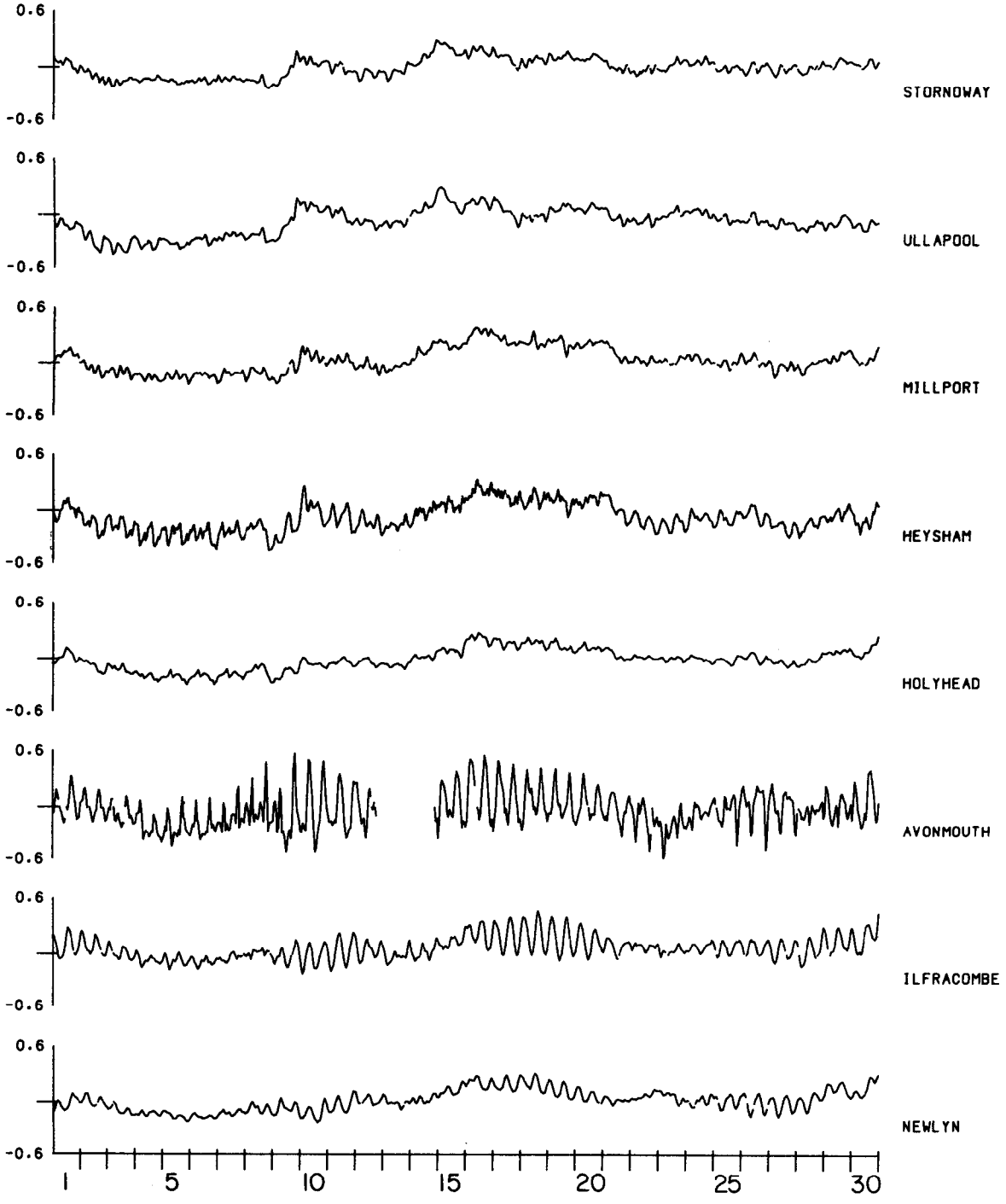
HOURLY RESIDUALS MARCH 1988
WEST COAST PORTS
(METRES)



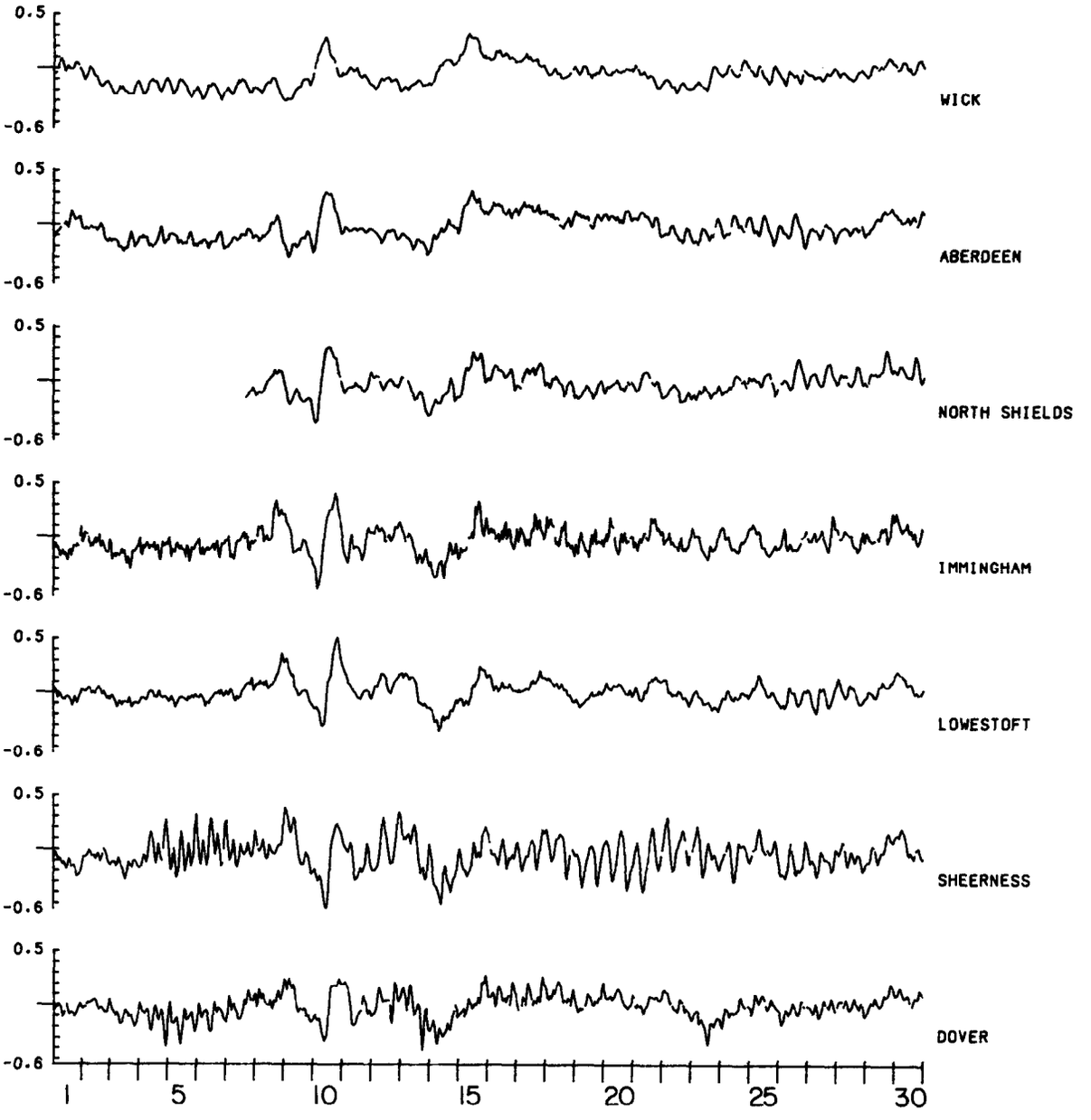
HOURLY RESIDUALS MARCH 1988
EAST COAST PORTS
(METRES)

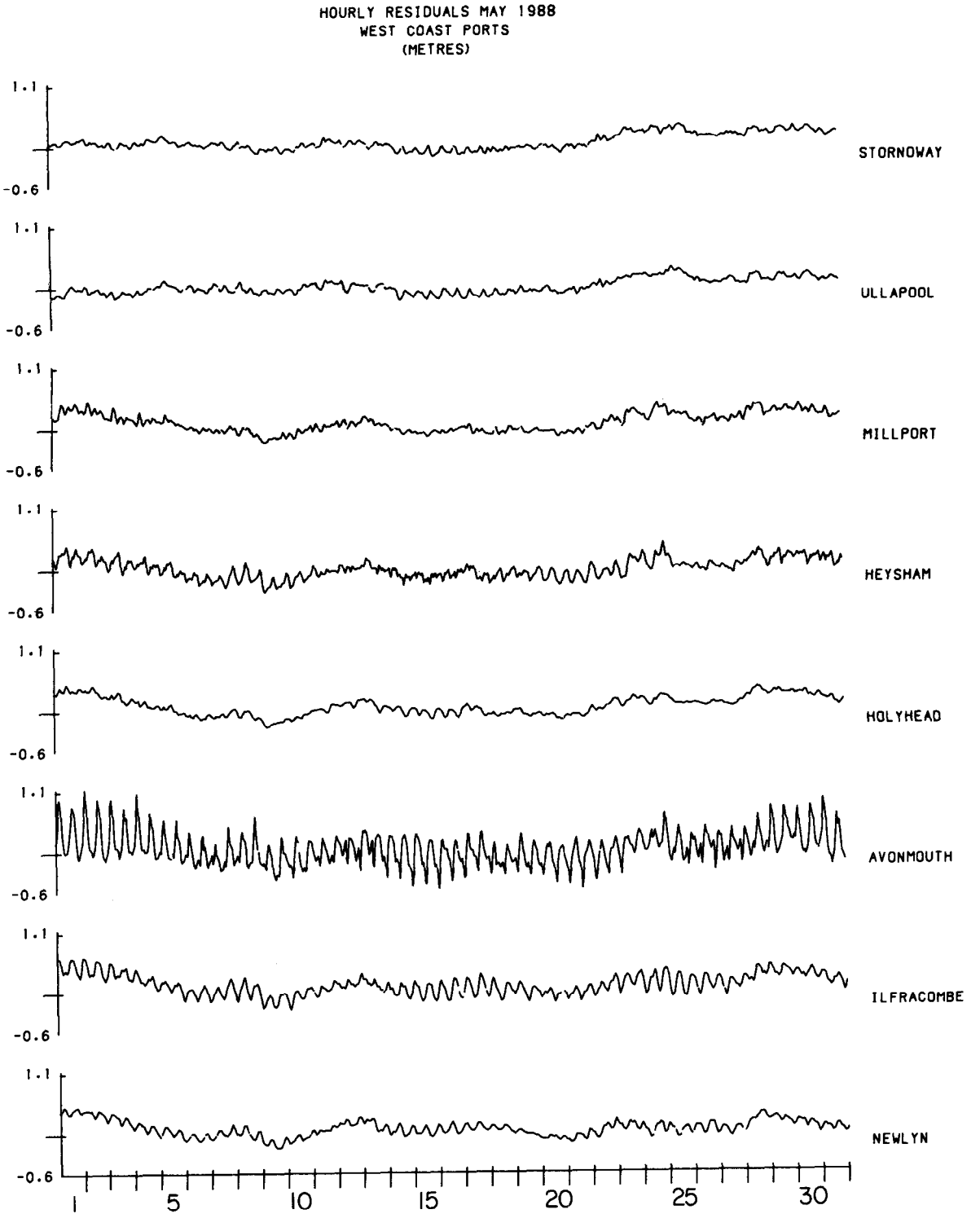


HOURLY RESIDUALS APRIL 1988
WEST COAST PORTS
(METRES)

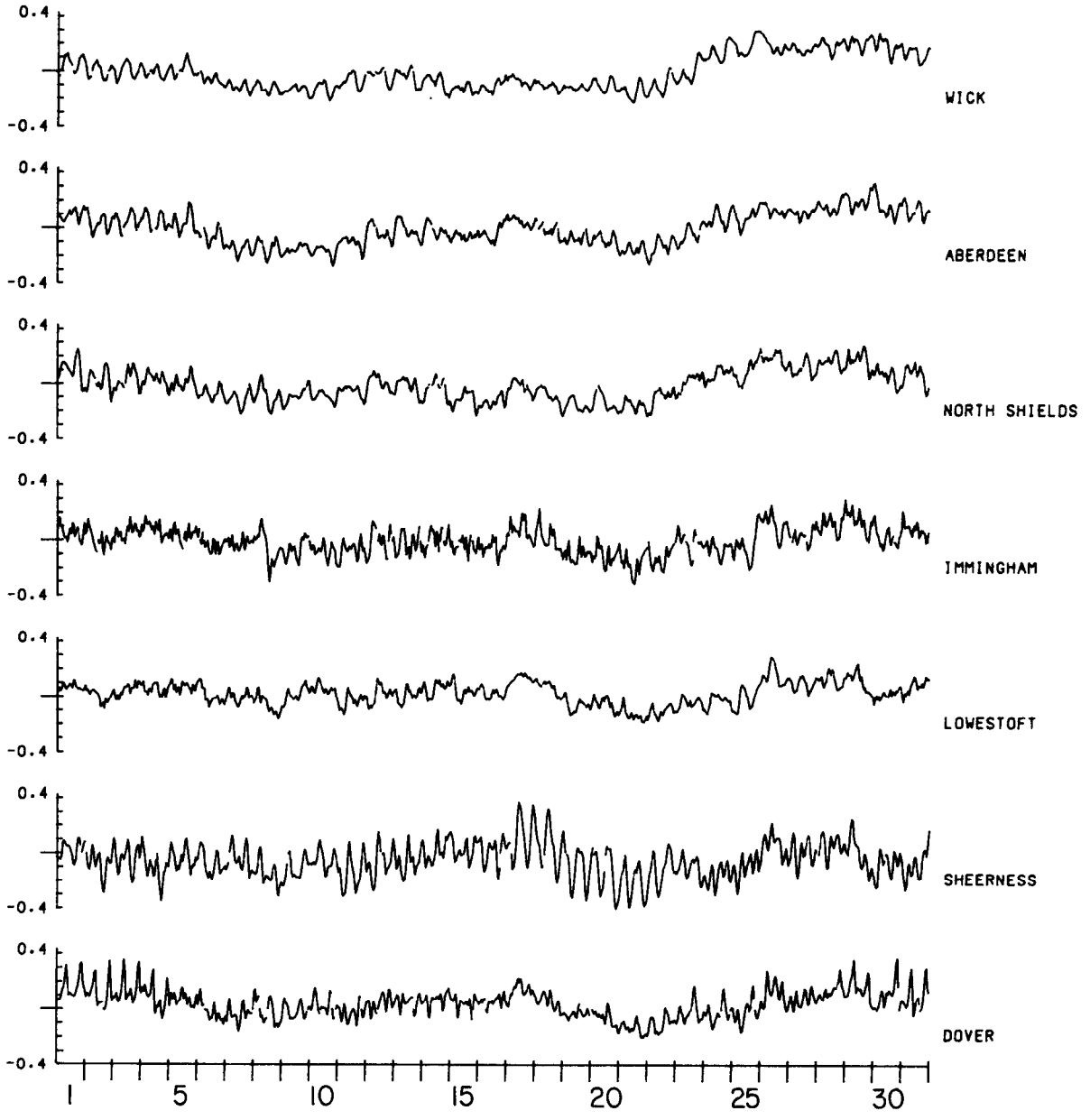


HOURLY RESIDUALS APRIL 1988
EAST COAST PORTS
(METRES)

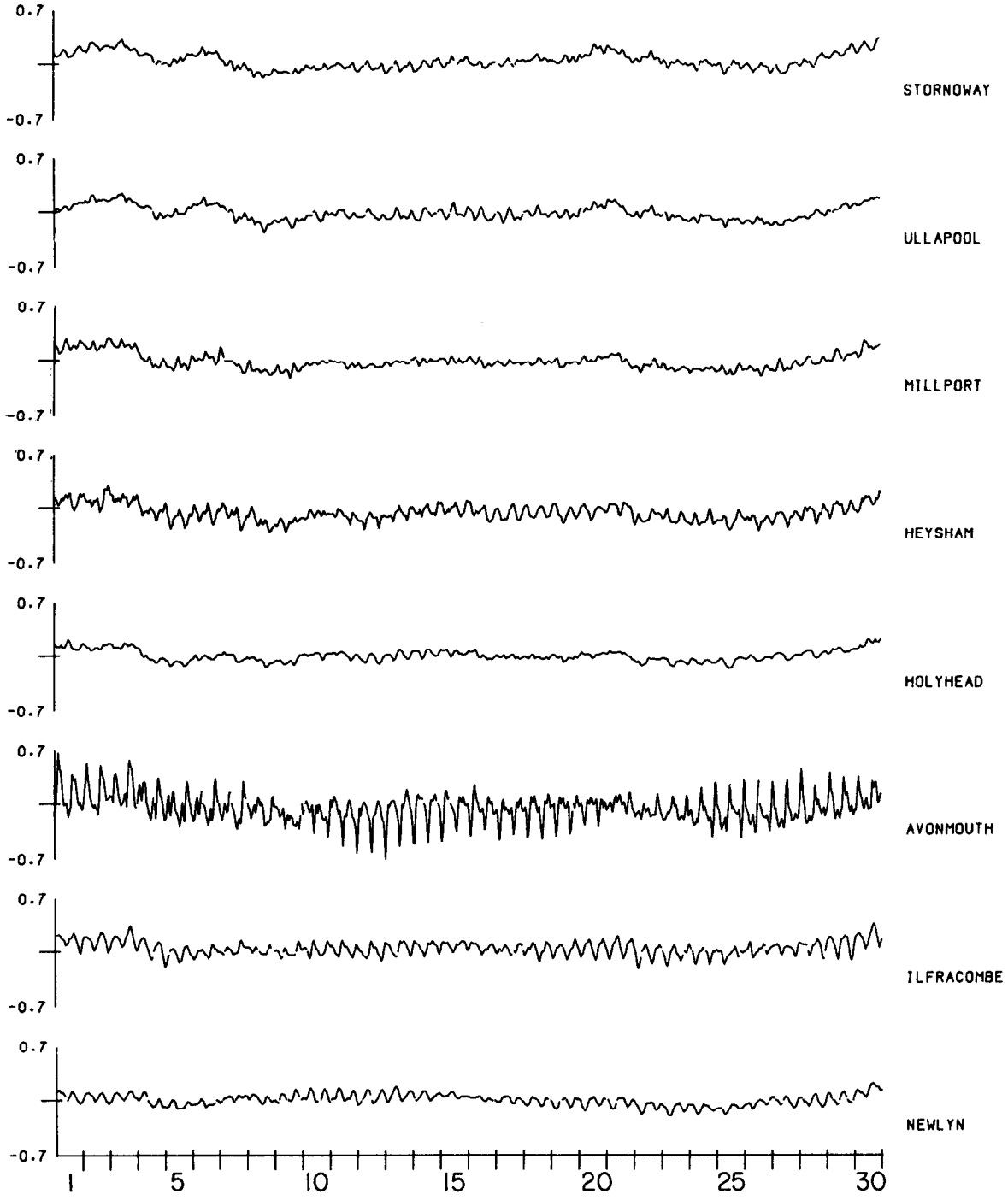



HOURLY RESIDUALS MAY 1988
WEST COAST PORTS
(METRES)
1.1
-0.6
STORNOWAY
ULLAPOOL
MILLPORT
HEYSHAM
HOLYHEAD
AVONMOUTH
ILFRACOMBE
NEWLYN
1
5
10
15
20
25
30

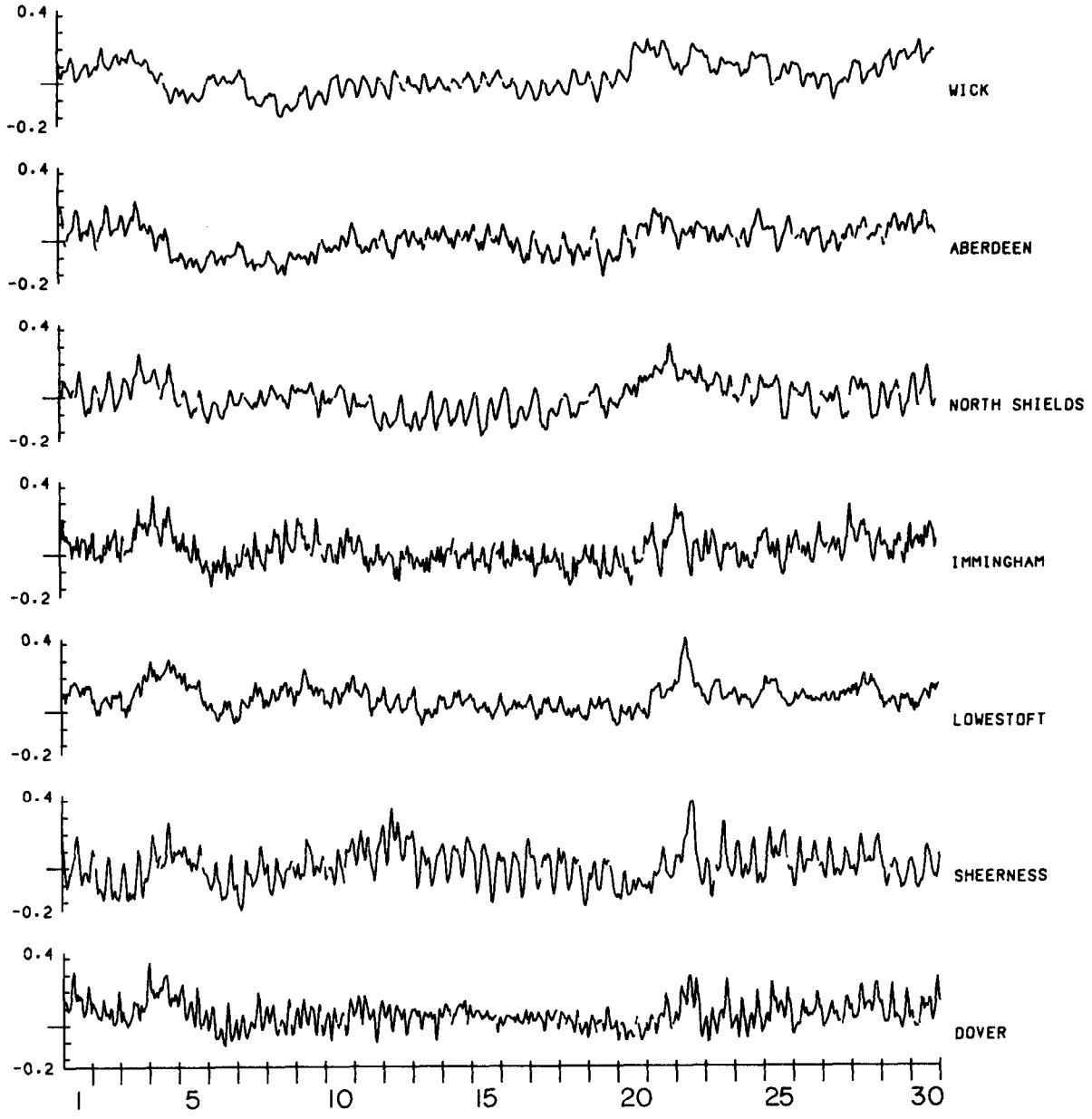
HOURLY RESIDUALS MAY 1988
EAST COAST PORTS
(METRES)

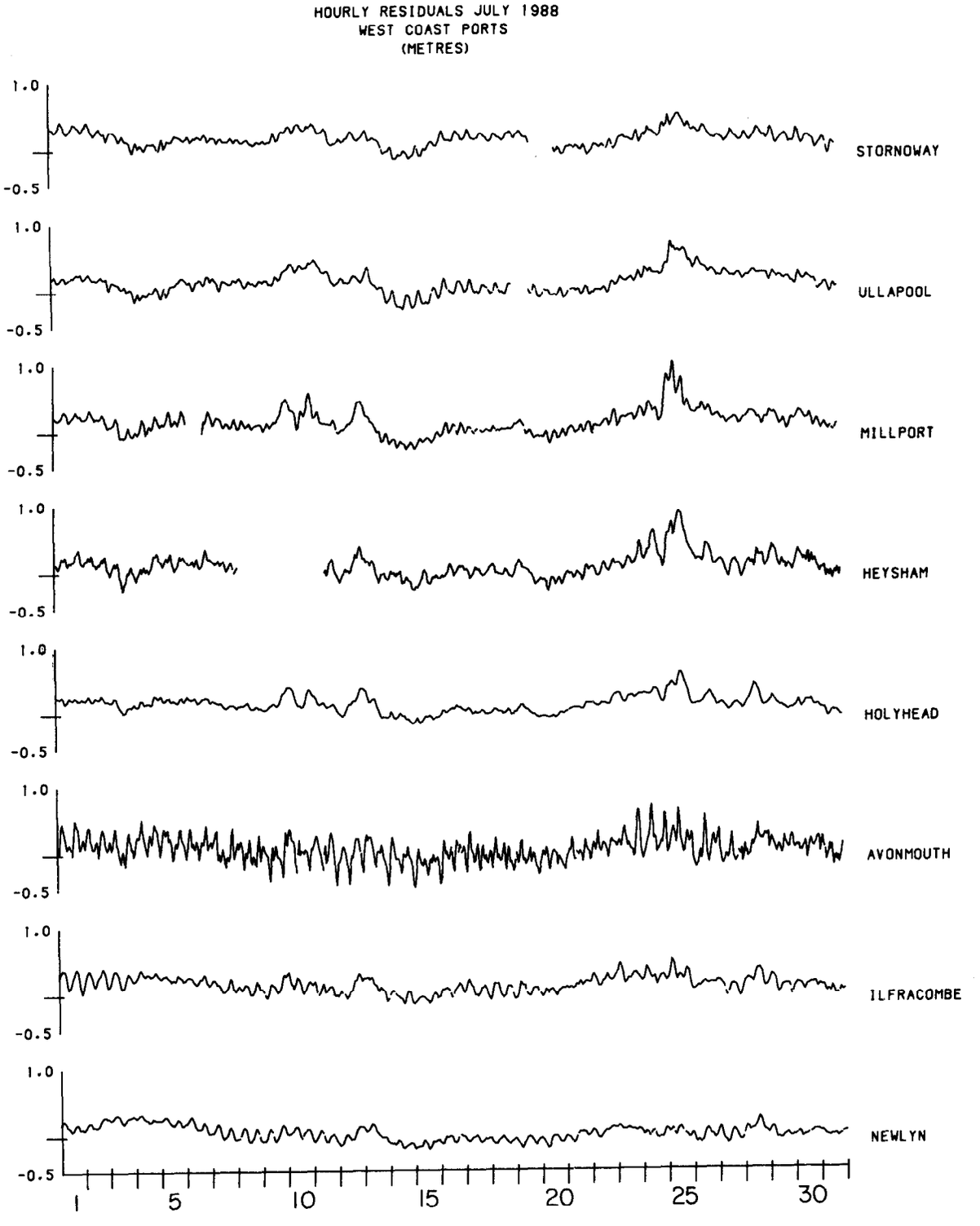


HOURLY RESIDUALS JUNE 1988
WEST COAST PORTS
(METRES)

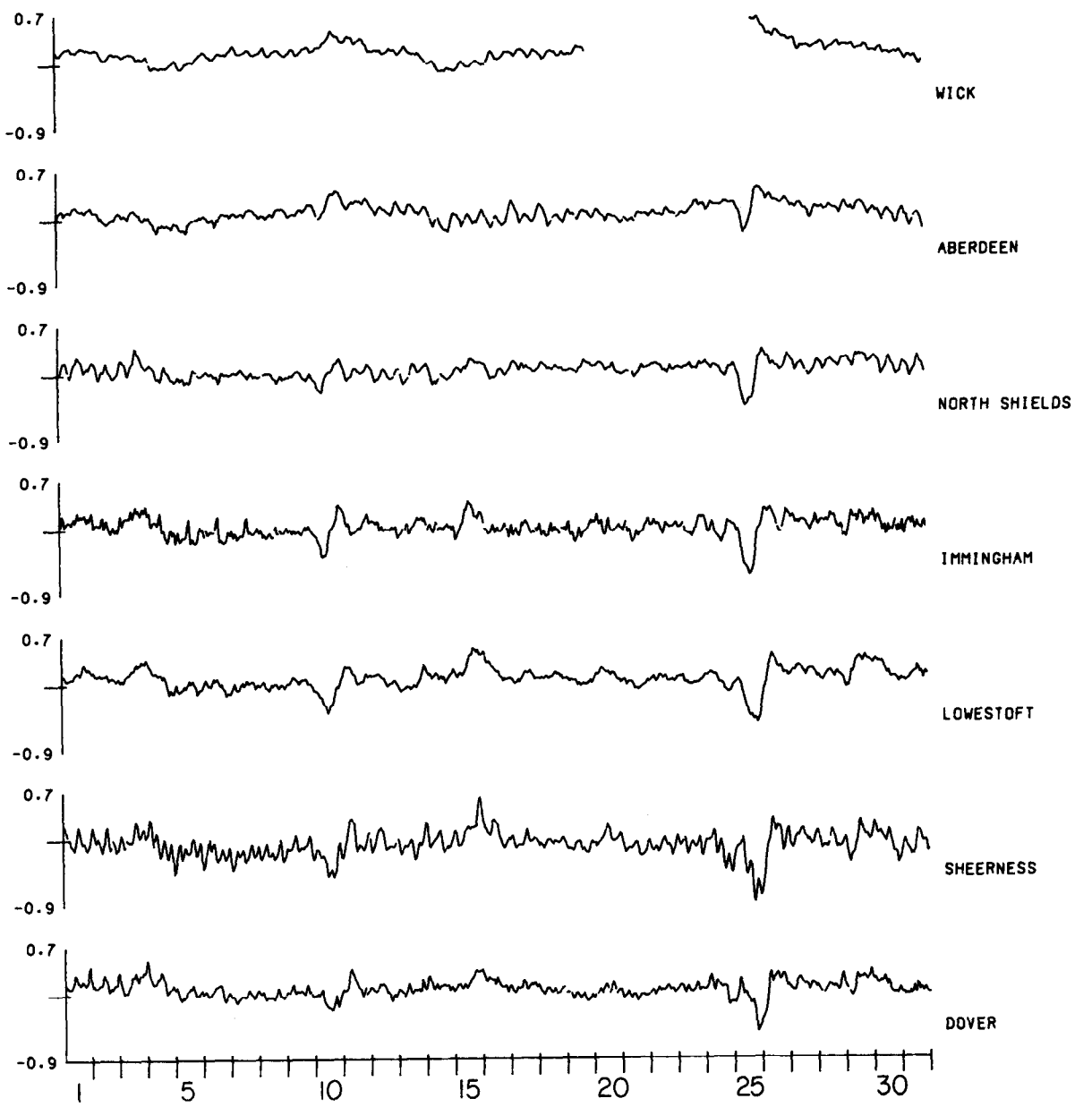


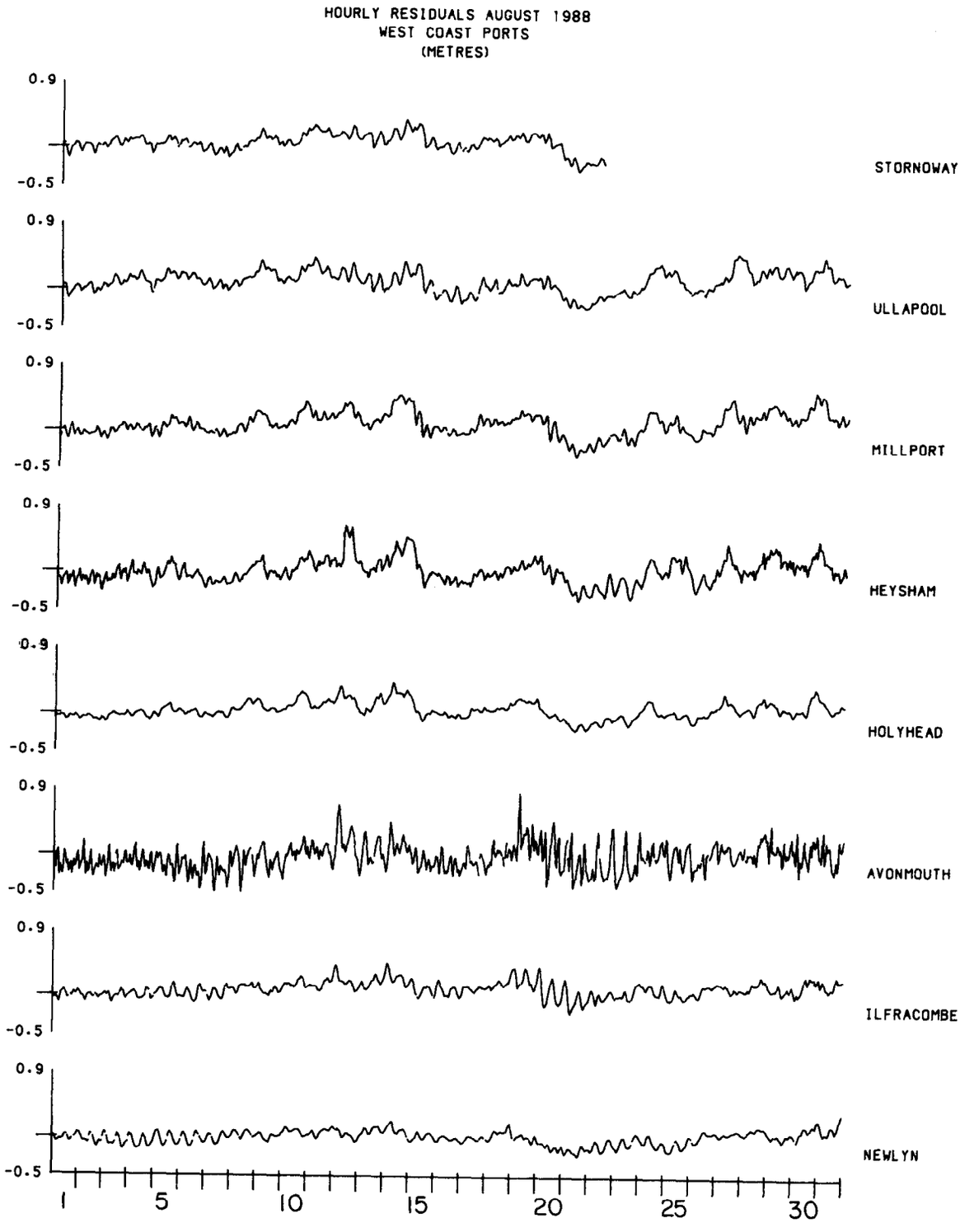
HOURLY RESIDUALS JUNE 1988
EAST COAST PORTS
(METRES)

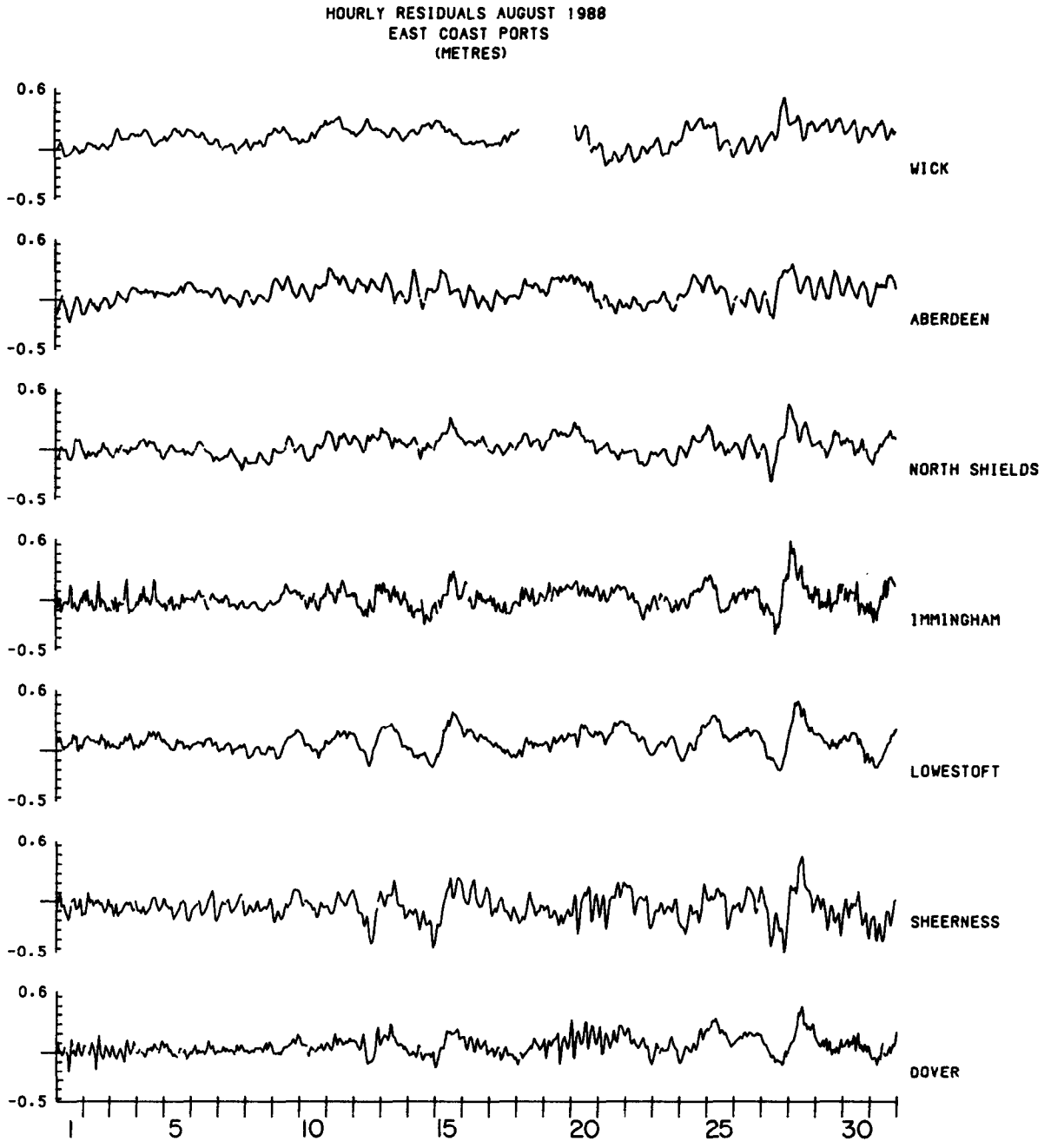



HOURLY RESIDUALS JULY 1988
WEST COAST PORTS
(METRES)
1.0
-0.5
STORNOWAY
ULLAPOOL
MILLPORT
HEYSHAM
HOLYHEAD
AVONMOUTH
ILFRACOMBE
NEWLYN
1
5
10
15
20
25
30

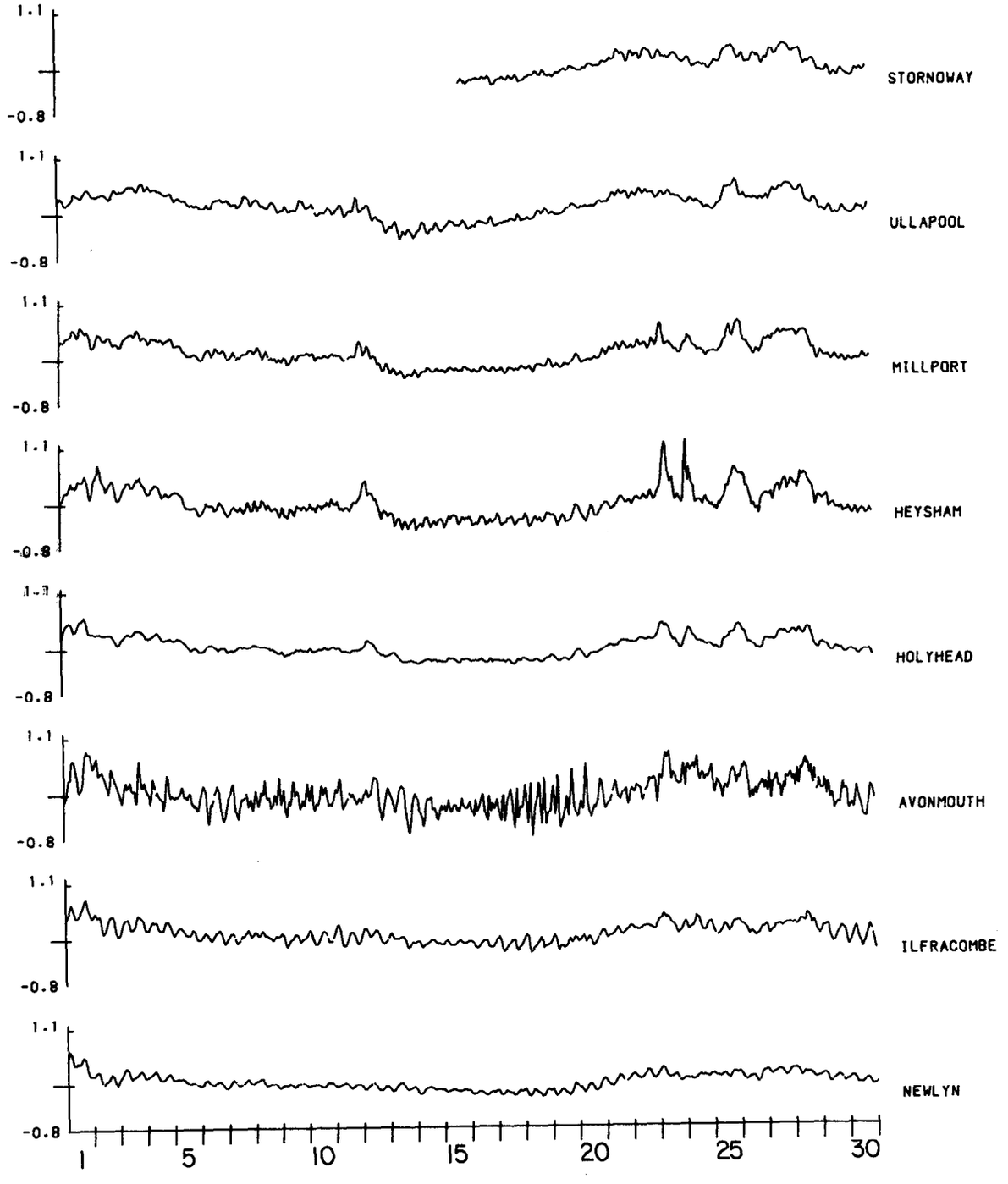
HOURLY RESIDUALS JULY 1988
EAST COAST PORTS
(METRES)

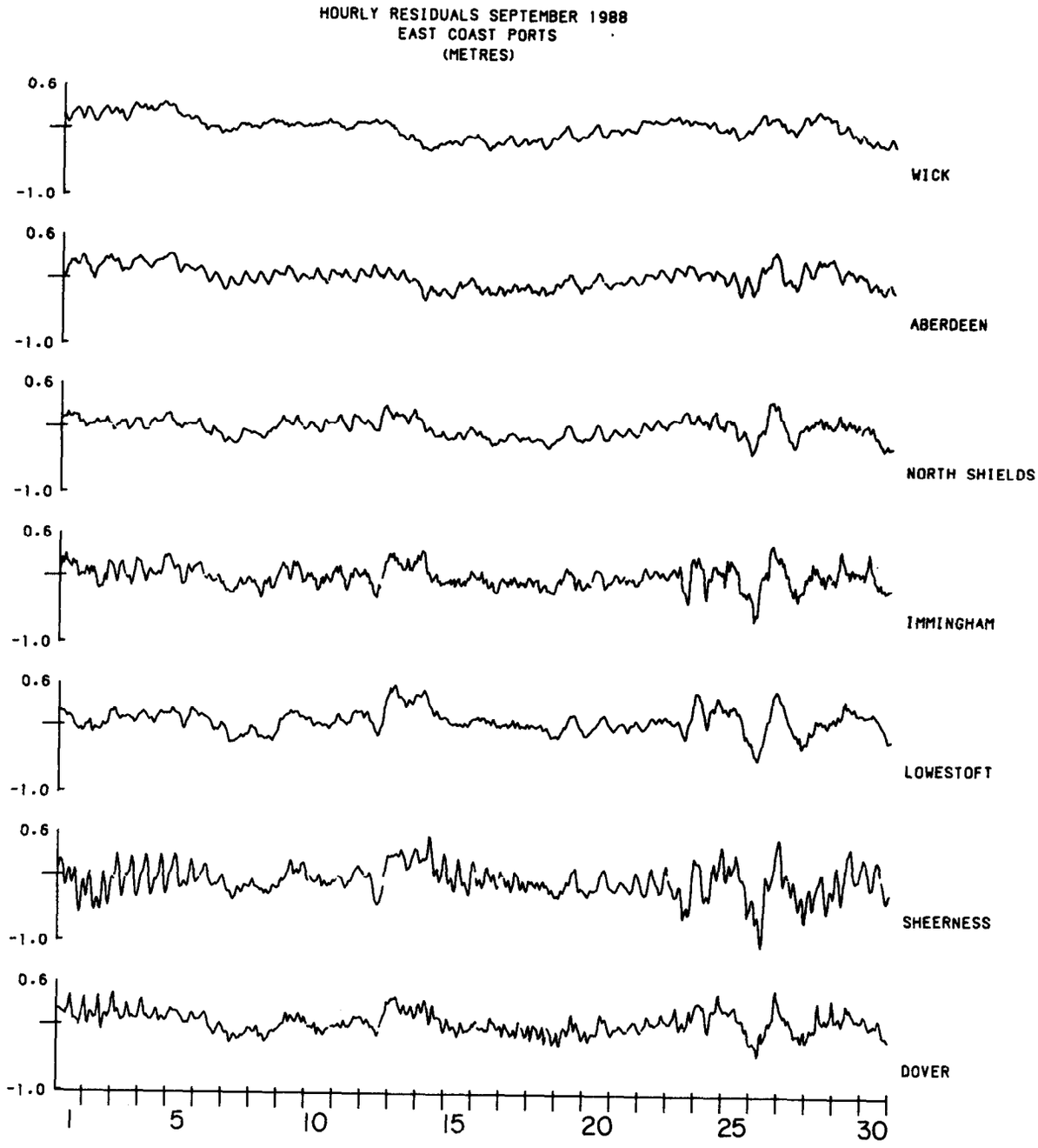



HOURLY RESIDUALS AUGUST 1988
WEST COAST PORTS
(METRES)
0.9
-0.5
STORNOWAY
ULLAPOOL
MILLPORT
HEYSHAM
HOLYHEAD
AVONMOUTH
ILFRACOMBE
NEWLYN
1
5
10
15
20
25
30

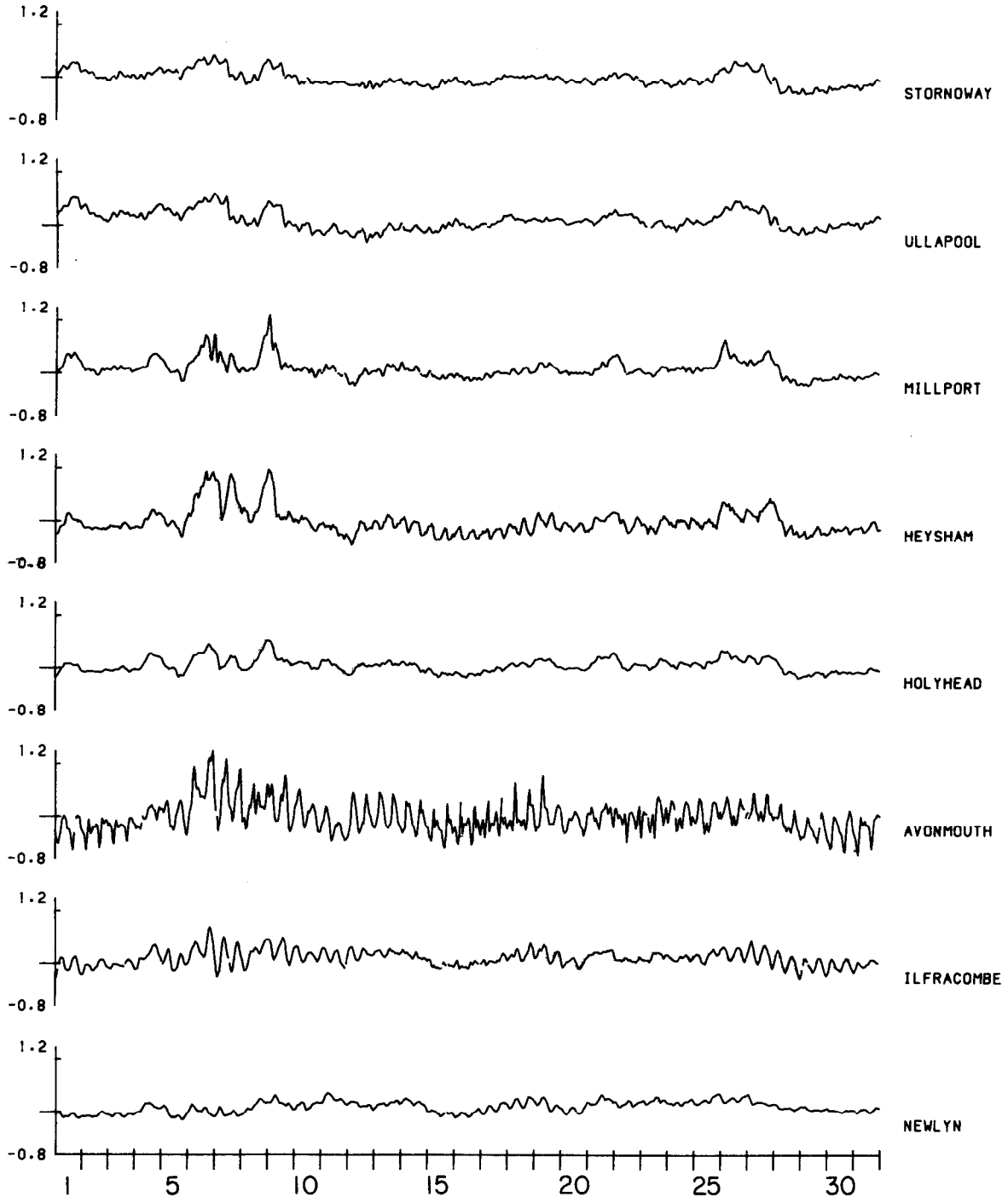

HOURLY RESIDUALS AUGUST 1988
EAST COAST PORTS
(METRES)
0.6
-0.5
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER
1
5
10
15
20
25
30

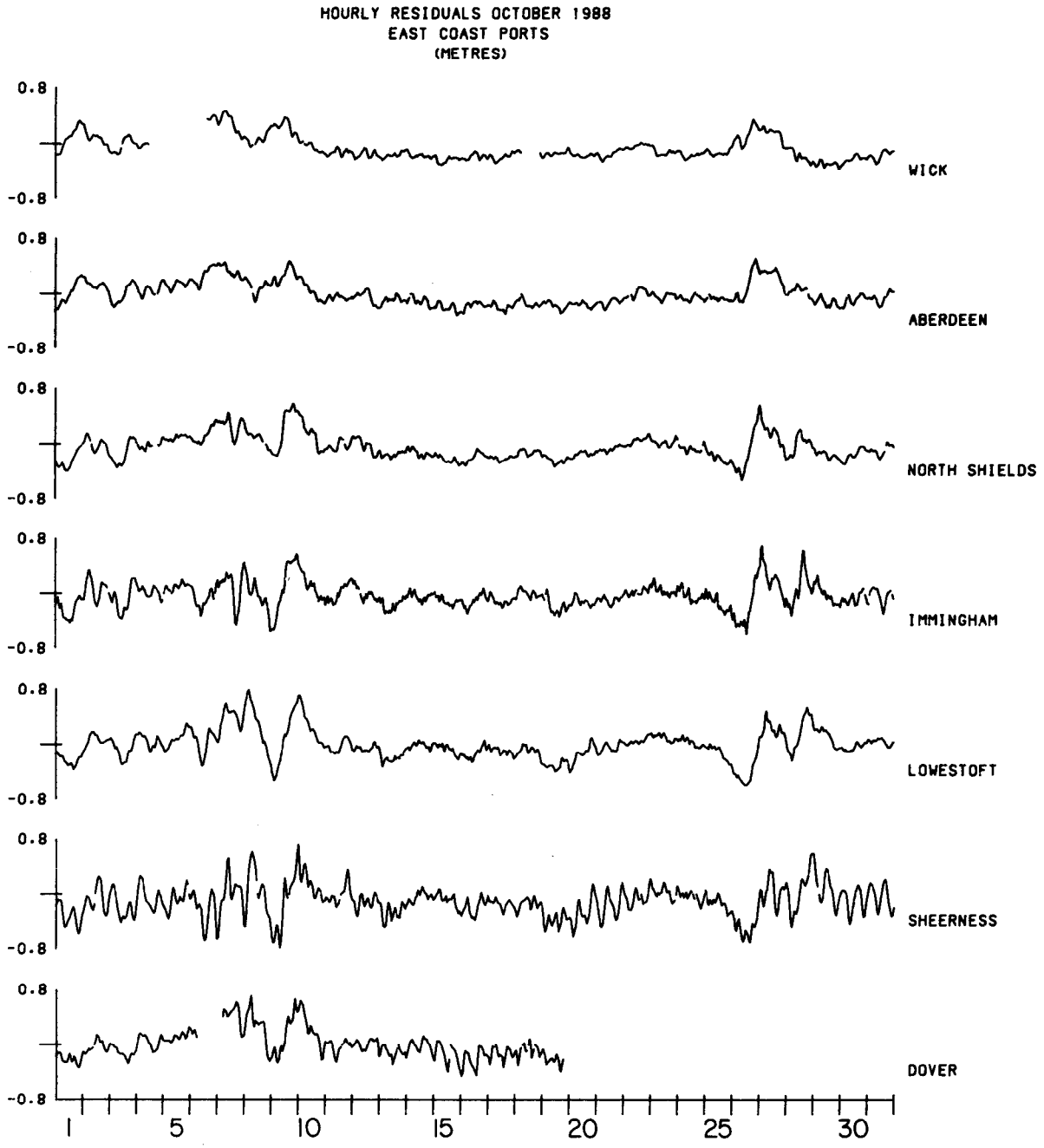
HOURLY RESIDUALS SEPTEMBER 1988
WEST COAST PORTS
(METRES)



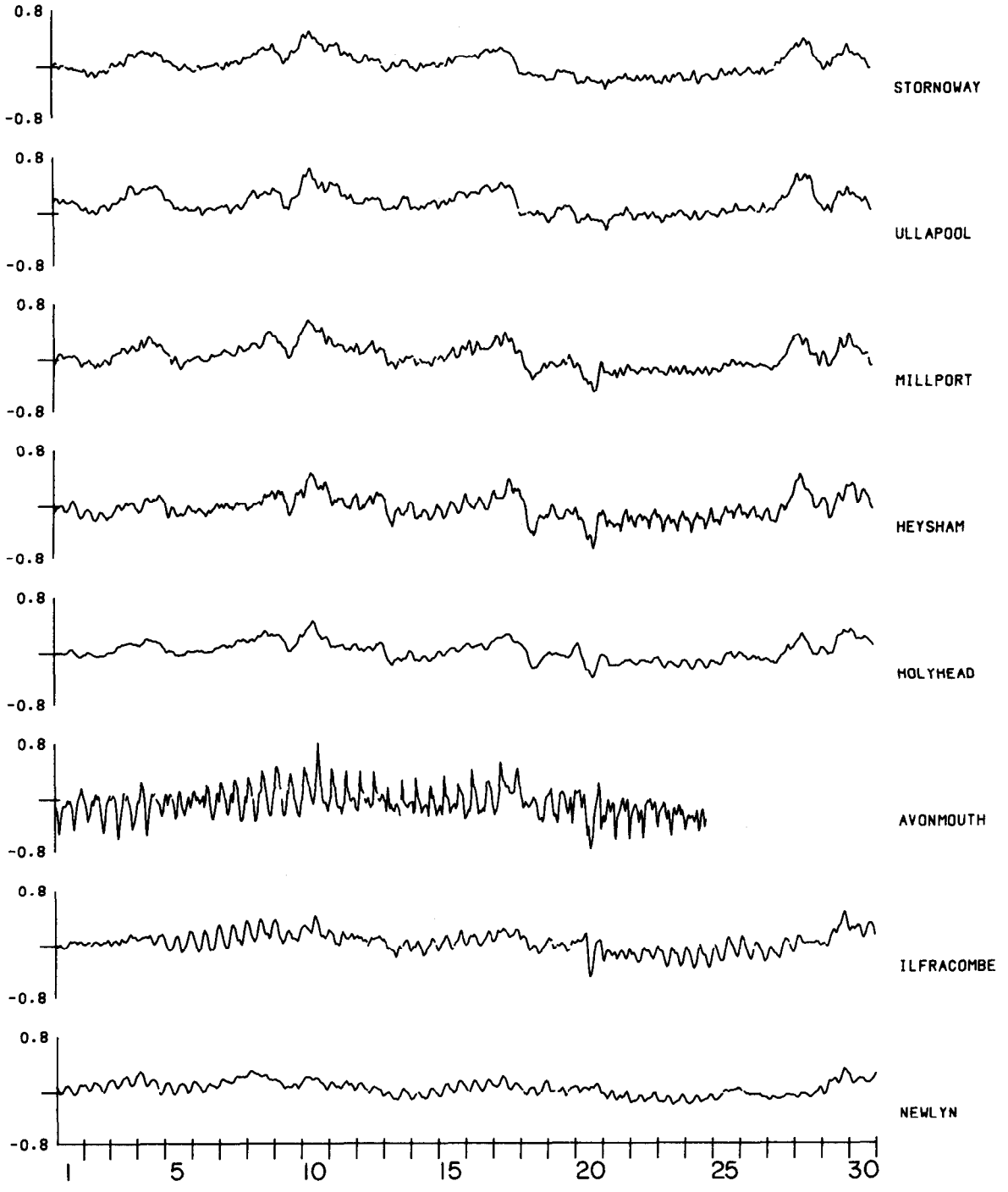

HOURLY RESIDUALS SEPTEMBER 1988
EAST COAST PORTS
(METRES)
0.6
-1.0
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER
1
5
10
15
20
25
30

HOURLY RESIDUALS OCTOBER 1988
WEST COAST PORTS
(METRES)

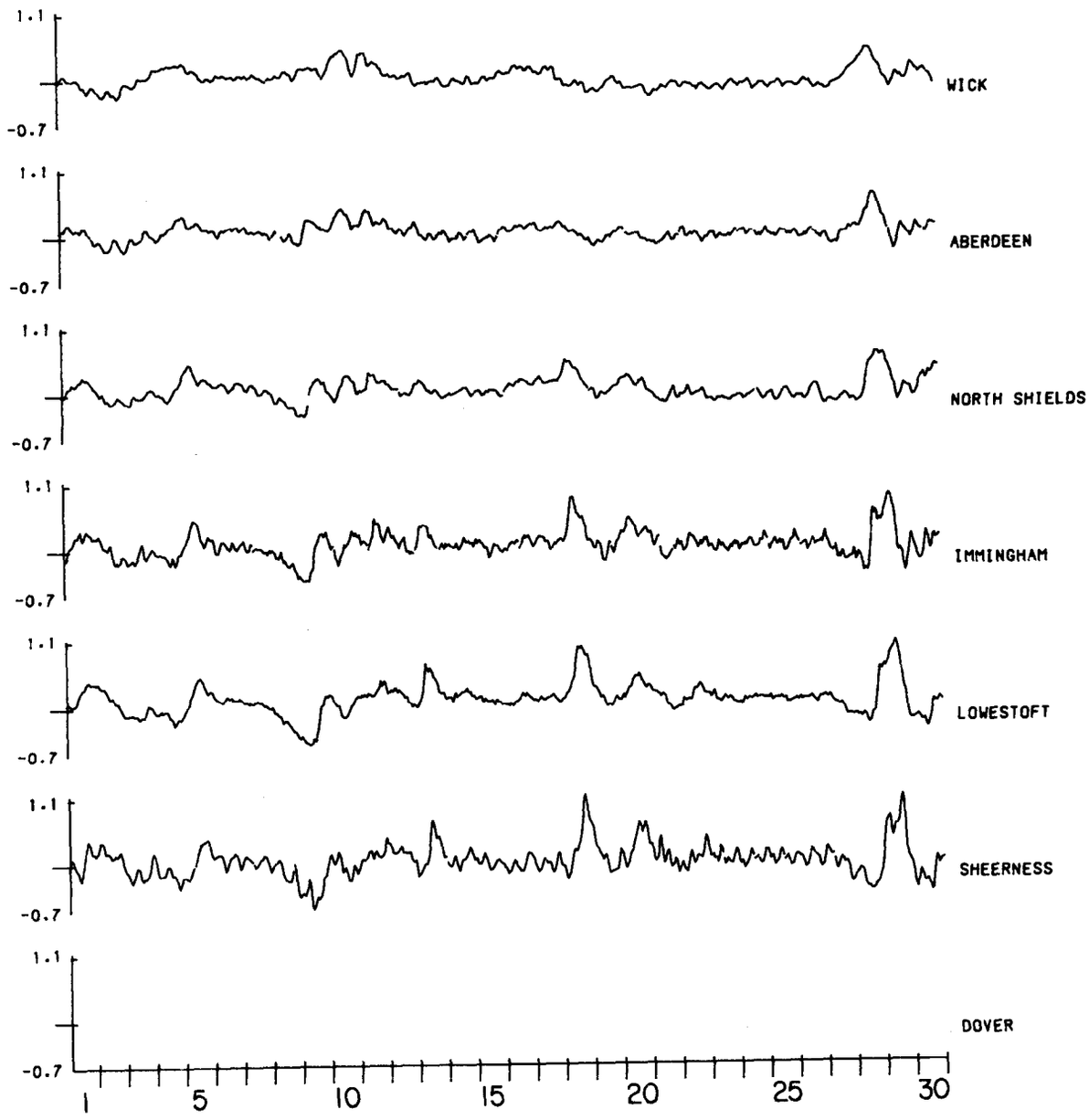



HOURLY RESIDUALS OCTOBER 1988
EAST COAST PORTS
(METRES)
0.8
-0.8
WICK
ABERDEEN
NORTH SHIELDS
IMMINGHAM
LOWESTOFT
SHEERNESS
DOVER
1
5
10
15
20
25
30

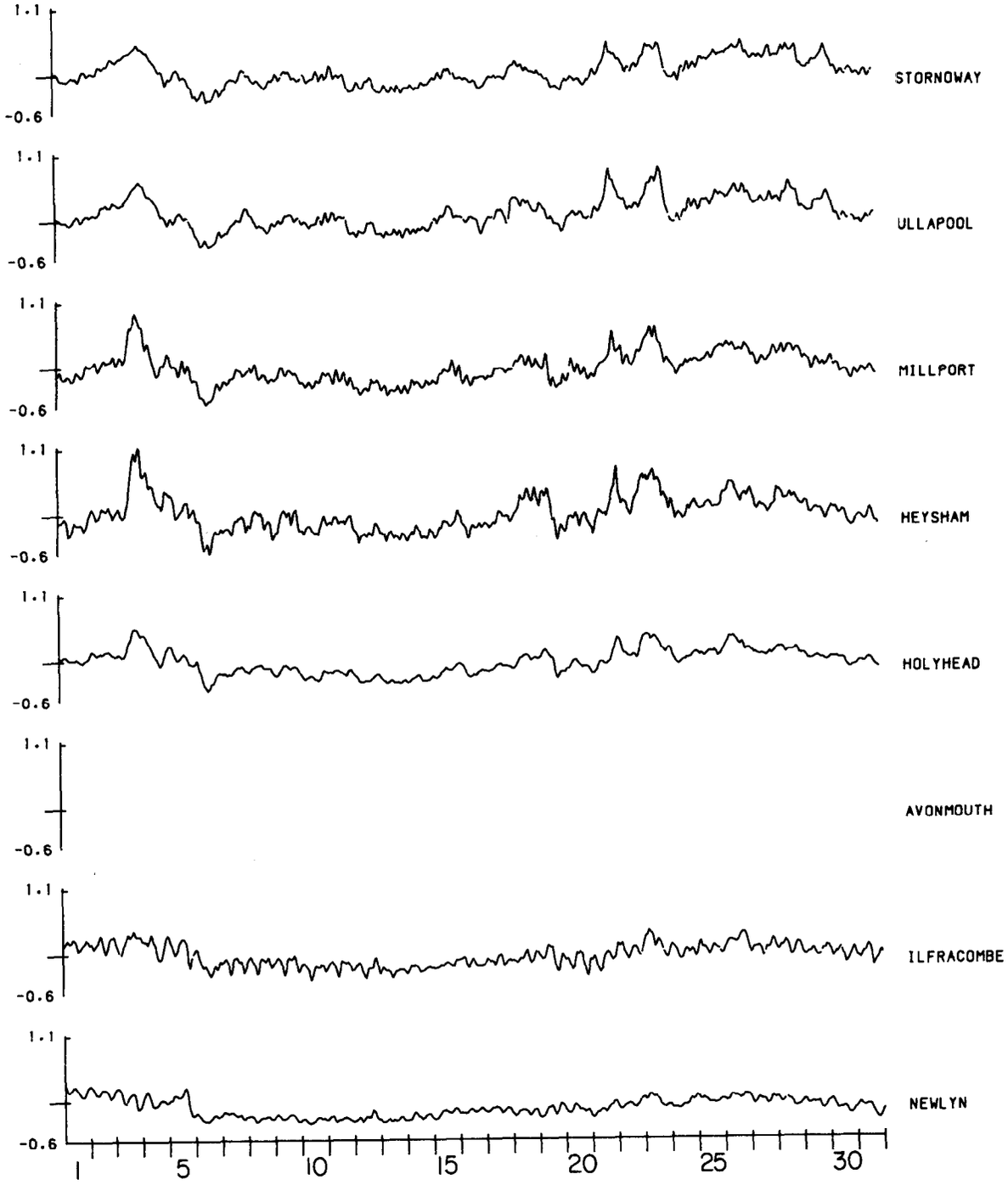
HOURLY RESIDUALS NOVEMBER 1988
WEST COAST PORTS
(METRES)



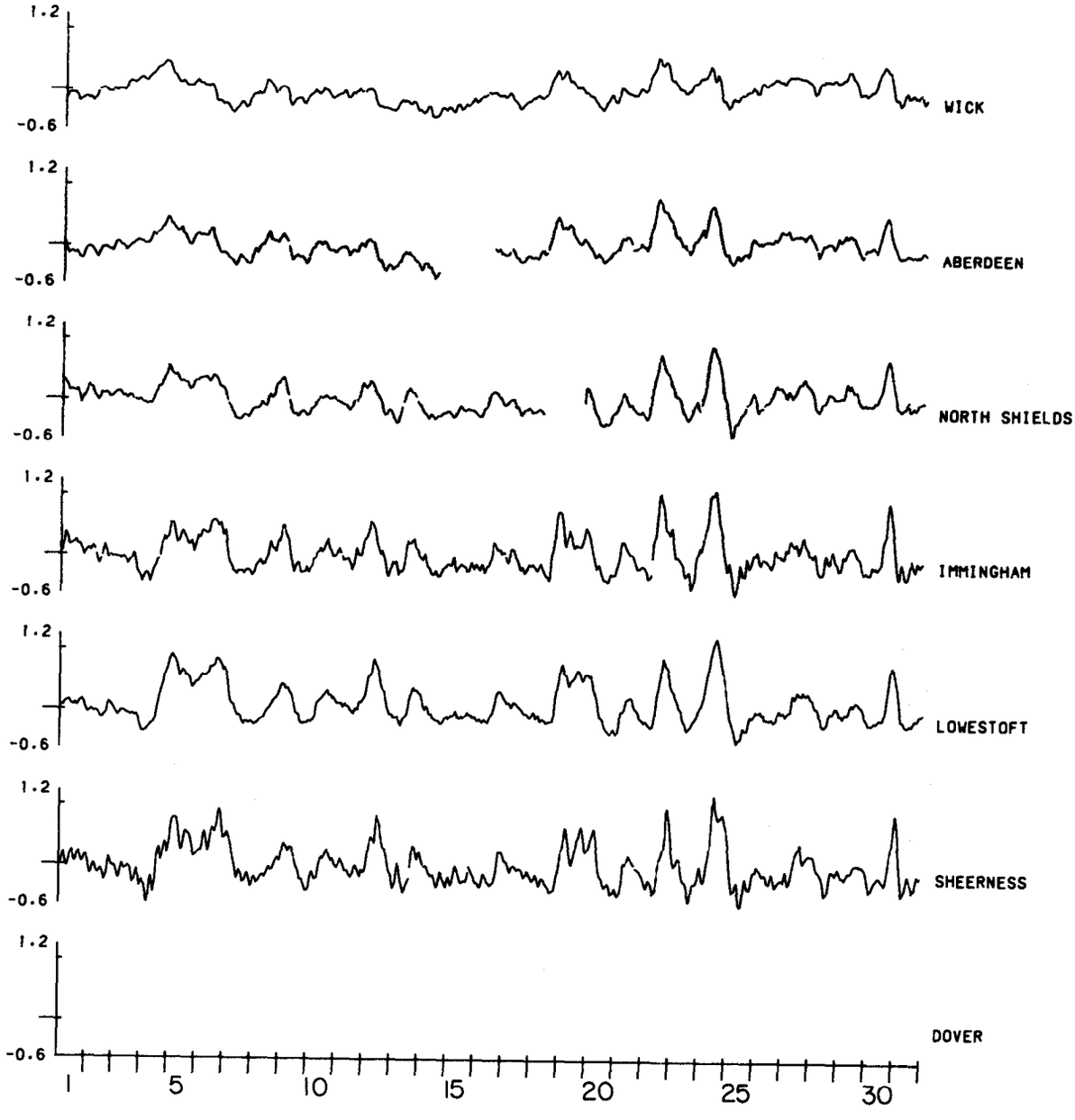
HOURLY RESIDUALS NOVEMBER 1988
EAST COAST PORTS
(METRES)



HOURLY RESIDUALS DECEMBER 1988
WEST COAST PORTS
(METRES)



HOURLY RESIDUALS DECEMBER 1988
EAST COAST PORTS
(METRES)



RESIDUAL STATISTICS 1988

WEST COAST PORTS

| PORT | STAT | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STORNOWAY | MEAN | .166 | .052 | .051 | .002 | .069 | .048 | .154 | .084 | .023 | .010 | .032 | .020 | .060 |
| | MAX | .665 | .872 | .551 | .318 | .331 | .349 | .477 | .400 | .399 | .435 | .530 | .466 | .872 |
| | MIN | -.225 | -.459 | -.325 | -.242 | -.178 | -.187 | -.147 | -.263 | -.307 | -.282 | -.335 | -.426 | -.459 |
| | S.D. | .185 | .240 | .156 | .117 | .114 | .105 | .114 | .117 | .179 | .141 | .169 | .191 | |
| ULLAPOOL | MEAN | .101 | -.037 | -.047 | -.073 | .004 | -.012 | .121 | .136 | .117 | .122 | .140 | .094 | .055 |
| | MAX | .624 | .862 | .623 | .332 | .300 | .254 | .666 | .526 | .554 | .610 | .661 | .801 | .862 |
| | MIN | -.278 | -.526 | -.486 | -.465 | -.221 | -.276 | -.267 | -.202 | -.480 | -.296 | -.270 | -.405 | -.526 |
| | S.D. | .198 | .248 | .196 | .156 | .102 | .097 | .150 | .140 | .221 | .169 | .163 | .217 | |
| MILLPORT | MEAN | .173 | .056 | .062 | .043 | .080 | -.021 | .125 | .118 | .078 | .105 | .038 | -.030 | .069 |
| | MAX | 1.002 | 1.697 | .895 | .419 | .470 | .308 | .958 | .567 | .633 | 1.108 | .589 | .842 | 1.697 |
| | MIN | -.368 | -.682 | -.390 | -.252 | -.229 | -.252 | -.251 | -.299 | -.381 | -.241 | -.502 | -.556 | -.682 |
| | S.D. | .225 | .359 | .206 | .149 | .144 | .109 | .167 | .154 | .224 | .179 | .183 | .223 | |
| HEYSHAM | MEAN | .208 | .107 | .012 | -.075 | -.009 | -.070 | .085 | .035 | -.020 | -.002 | -.034 | -.012 | .018 |
| | MAX | 1.057 | 2.424 | 1.158 | .372 | .410 | .298 | .830 | .615 | 1.091 | 1.003 | .492 | 1.041 | 2.424 |
| | MIN | -.300 | -.727 | -.488 | -.467 | -.366 | -.350 | -.285 | -.341 | -.506 | -.454 | -.631 | -.598 | -.727 |
| | S.D. | .224 | .442 | .225 | .160 | .151 | .110 | .167 | .163 | .265 | .239 | .174 | .253 | |
| HOLYHEAD | MEAN | .191 | .032 | .004 | -.008 | .069 | .000 | .114 | .066 | .011 | .063 | .028 | -.038 | .045 |
| | MAX | .675 | 1.216 | .716 | .310 | .452 | .237 | .557 | .421 | .579 | .562 | .466 | .509 | 1.216 |
| | MIN | -.279 | -.480 | -.374 | -.301 | -.259 | -.175 | -.167 | -.201 | -.311 | -.184 | -.384 | -.452 | -.480 |
| | S.D. | .185 | .284 | .160 | .131 | .144 | .079 | .120 | .111 | .192 | .132 | .145 | .181 | |
| AVONMOUTH | MEAN | .133 | .050 | .111 | -.034 | .048 | -.057 | .051 | -.010 | -.023 | -.007 | -.055 | | .019 |
| | MAX | 1.345 | 1.888 | 1.432 | .631 | 1.047 | .701 | .674 | .829 | .776 | 1.245 | .829 | | 1.888 |
| | MIN | -.805 | -.685 | -.875 | -.590 | -.617 | -.747 | -.489 | -.484 | -.788 | -.714 | -.755 | | -.875 |
| | S.D. | .291 | .389 | .261 | .213 | .264 | .189 | .173 | .178 | .265 | .290 | .209 | | |
| ILFRACOMBE | MEAN | .212 | .097 | .094 | .073 | .120 | .041 | .132 | .103 | .066 | .111 | .042 | -.046 | .087 |
| | MAX | .866 | 1.044 | .934 | .511 | .624 | .387 | .470 | .438 | .729 | .703 | .496 | .356 | 1.044 |
| | MIN | -.405 | -.583 | -.361 | -.234 | -.277 | -.232 | -.140 | -.200 | -.311 | -.299 | -.475 | -.404 | -.583 |
| | S.D. | .192 | .263 | .161 | .136 | .168 | .095 | .116 | .104 | .172 | .148 | .151 | .158 | |
| NEWLYN | MEAN | .073 | -.062 | -.051 | .025 | .070 | -.003 | .024 | .017 | .004 | .106 | .050 | -.128 | .011 |
| | MAX | .577 | .428 | .380 | .342 | .459 | .231 | .314 | .349 | .599 | .374 | .335 | .273 | .599 |
| | MIN | -.294 | -.647 | -.337 | -.240 | -.238 | -.230 | -.205 | -.219 | -.280 | -.157 | -.188 | -.347 | -.647 |
| | S.D. | .161 | .164 | .140 | .126 | .129 | .078 | .116 | .091 | .143 | .117 | .109 | .139 | |

RESIDUAL STATISTICS 1988

EAST COAST PORTS

| PORT | STAT | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WICK | MEAN | .146 | .048 | -.012 | -.059 | .000 | .029 | .160 | .133 | .060 | -.057 | -.010 | .031 | .039 |
| | MAX | .679 | .758 | .360 | .328 | .307 | .245 | .681 | .555 | .398 | .463 | .444 | .599 | .758 |
| | MIN | -.233 | -.302 | -.252 | -.305 | -.220 | -.202 | -.126 | -.188 | -.306 | -.336 | -.301 | -.422 | -.422 |
| | S.D. | .202 | .201 | .118 | .115 | .129 | .091 | .128 | .112 | .156 | .161 | .149 | .204 | |
| ABERDEEN | MEAN | .104 | .047 | .035 | -.025 | .003 | -.004 | .078 | .078 | .065 | .000 | .041 | .051 | .040 |
| | MAX | .689 | .728 | .586 | .320 | .337 | .239 | .419 | .386 | .480 | .510 | .584 | .865 | .865 |
| | MIN | -.538 | -.356 | -.412 | -.301 | -.267 | -.217 | -.222 | -.243 | -.296 | -.305 | -.282 | -.522 | -.538 |
| | S.D. | .211 | .181 | .142 | .117 | .118 | .084 | .111 | .112 | .145 | .165 | .133 | .220 | |
| N.SHIELDS | MEAN | .088 | .073 | .046 | -.013 | -.004 | -.009 | .051 | .036 | .024 | -.042 | .041 | .055 | .029 |
| | MAX | .627 | .753 | .745 | .308 | .292 | .307 | .387 | .493 | .470 | .560 | .579 | .971 | .971 |
| | MIN | -.697 | -.636 | -.488 | -.398 | -.234 | -.226 | -.485 | -.338 | -.347 | -.498 | -.363 | -.542 | -.697 |
| | S.D. | .201 | .235 | .179 | .116 | .115 | .093 | .109 | .109 | .139 | .173 | .161 | .236 | |
| IMMINGHAM | MEAN | .011 | .014 | .023 | -.036 | -.001 | .019 | .020 | .020 | .034 | -.027 | .063 | .042 | .015 |
| | MAX | .693 | 1.394 | .795 | .407 | .313 | .354 | .401 | .641 | .554 | .688 | .794 | 1.141 | 1.394 |
| | MIN | -.790 | -1.187 | -.866 | -.493 | -.308 | -.195 | -.679 | -.357 | -.618 | -.554 | -.481 | -.587 | -1.187 |
| | S.D. | .219 | .341 | .224 | .121 | .099 | .087 | .139 | .114 | .159 | .180 | .193 | .284 | |
| LOWESTOFT | MEAN | .089 | .166 | .139 | .008 | .028 | .079 | .076 | .101 | .109 | .002 | .097 | .129 | .085 |
| | MAX | .665 | 1.585 | .863 | .506 | .299 | .427 | .512 | .551 | .648 | .778 | .935 | 1.247 | 1.585 |
| | MIN | -.589 | -1.059 | -.801 | -.351 | -.182 | -.095 | -.574 | -.201 | -.458 | -.574 | -.575 | -.485 | -1.059 |
| | S.D. | .228 | .413 | .249 | .110 | .085 | .077 | .146 | .119 | .176 | .213 | .228 | .310 | |
| SHEERNESS | MEAN | -.034 | -.013 | -.003 | -.048 | -.048 | .007 | -.089 | -.060 | -.052 | -.099 | .024 | .021 | -.033 |
| | MAX | .669 | 1.593 | 1.045 | .384 | .381 | .393 | .602 | .490 | .628 | .708 | 1.021 | 1.210 | 1.593 |
| | MIN | -1.098 | -1.525 | -1.222 | -.547 | -.400 | -.248 | -.932 | -.526 | -1.017 | -.764 | -.692 | -.615 | -1.525 |
| | S.D. | .258 | .455 | .294 | .147 | .126 | .107 | .174 | .138 | .226 | .224 | .236 | .310 | |
| DOVER | MEAN | .119 | .127 | .119 | -.012 | .043 | .058 | .067 | .071 | .074 | -.003 | | | .069 |
| | MAX | .949 | 1.114 | .884 | .279 | .376 | .374 | .495 | .502 | .598 | .686 | | | 1.114 |
| | MIN | -.509 | -1.016 | -.600 | -.420 | -.203 | -.134 | -.572 | -.210 | -.412 | -.440 | | | -1.016 |
| | S.D. | .205 | .313 | .203 | .115 | .102 | .079 | .123 | .100 | .157 | .212 | | | |

## 4. OTHER INSTALLATIONS

### 4.1 TOBERMORY

Hourly data from 6 August 1987,but with many gaps.

This site was upgraded to Dataring and on-line from 6 August 1987,but beset by many problems including clock-card errors and spates of memory loss until T.G.I. renewed the clock-card and cleaned the connectors on their visit of 1 December 1987.

Frequent memory losses continued to occur and were eventually traced to a dry joint in the power unit board which was replaced by T.G.I. on their visit of 3-5 July 1988.

Thus,as far as the dataring system for 1988 is concerned, hourly levels commence 4 July.Values from a supporting Aanderaa pressure gauge have been processed for January to July.

### 4.2 CROMER

Originally a temporary installation with Aanderaa pressure gauge recordings,the site was modernised in March 1988 and furnished with two digiquartz sensors on pressure systems.Hourly levels have been filtered from the raw values since 2 March with minimal data loss (27-30 April; 8-9 June).

The pressure points were capped on 16 June to reduce high wave activity in the tubing.

### 4.3 FISHGUARD

Hourly data commences 20 June 1988.

This station has been upgraded from a chart-recording Lea gauge with stilling well to a system with two pressure points with digiquartz sensors. The installation is now some 1/3 mile from the original site Apart from two small gaps in July,there have been no processing problems since installation.

4.4 FELIXSTOWE

Since becoming a permanent Class-A gauge site in 1980, records from an Aanderaa pressure recorder have provided a data series with limited reliability.

Now upgraded to dataring, the site has been refurbished with two pressure systems with digiquartz sensors.

Hourly levels have been processed from 14 September 1988 with no problems with the system.

4.5 LEITH

Upgraded to a dataring site in November 1988, with a potentiometer attached to the Munro gauge and another on a well-head unit.

There were many teething problems with the new system such that continuous data has been retrieved only since 31 December 1988.

4.6 MUMBLES

Two pressure systems with digiquartz sensors installed in November 1988. Problems with the telephone link have precluded the collection of data until January 1989.

5. ACKNOWLEDGEMENTS

The author gratefully acknowedges the work of the Tide Gauge Inspectorate of Proudman Laboratory who work so hard to maintain all the gauges on the Class-A Network; also all in Tidal Computations Group involved with the reduction of the data,the Ordnance Survey for their levelling efforts and supply of Bench Mark information and Ian Pratt of Storm Tide Warning who helped with the surge meteorological conditions.My thanks also to Joyce Richards for much of the drawing work and Joyce Scoffield who analysed the data series.

6. REFERENCES

HOME OFFICE 1954 . Report of the Departmental Committee on coastal flooding. London HMSO 48pp. Cmnd. 9165

GRAFF, J & KARUNARATNE, D.A. 1980. Accurate reduction of sea level records.

International Hydrographic Review, 57(2), 151-166.